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Poelt J., 1969. *Bestimmungschlüssel europäischer Flechten*. J. Cramer, Vaduz, 757 pp.

Trevisan R., Cappelletti E.M. & Caniato P., 1983. *Epicarp micro-characters in some european* Angelica *species*. Atti Accad. Naz. Lincei, Rend. Cl. Sci. fis., mat. e nat., 74: 77-82.

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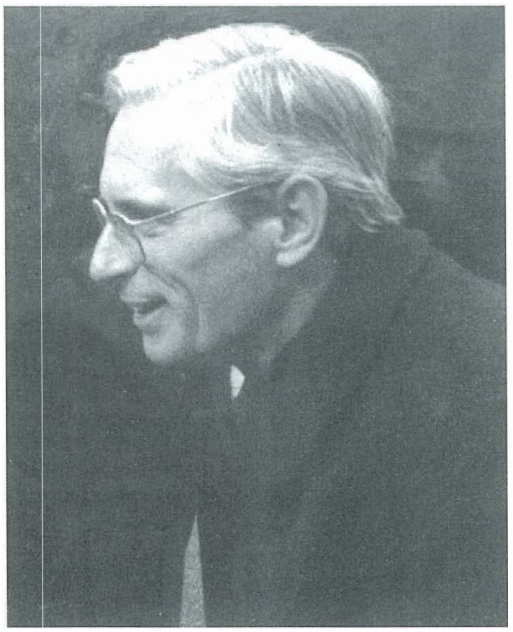
Il 16 marzo 1997 è venuto a mancare il Prof. Duilio Lausi, che è stato uno dei fondatori di questa rivista, e suo Direttore per lunghi anni. Chi lavora nell'ambito della Geobotanica conosce l'importante contributo da Lui dato in questa disciplina. In questa sede abbiamo voluto ricordare la Sua figura attraverso il ricordo di un amico e collega che per lunghi anni gli è stato vicino nella Sua ricca attività didattica e scientifica.

La Redazione

Un ricordo di Duilio Lausi (1923-1997)



Inutilmente cerco di ricordare quando incontrai Duilio Lausi per la prima volta. La sua capacità di comunicare in modo semplice e diretto con tutti lo rendeva immediatamente familiare e forse per questo non trovo un inizio della nostra amicizia, proprio come avviene con i parenti più stretti. Nonostante la irregolarità delle occasioni di trovarci, sempre per ragioni di lavoro e negli ultimi anni in particolare, per il dottorato di ricerca in geobotanica, il ritrovarsi significava riprendere un discorso già iniziato da tempo, sapendo che sarebbe stato presto interrotto, ma solo fino alla prossima riunione o telefonata. Una sequenza che purtroppo è giunta al termine.

Mi rendo conto che per commemorarlo in modo tradizionale su questa rivista di cui fu uno dei fondatori e animatore intelligente e attivo, dovrei svolgere un'analisi delle sue ricerche, dei suoi viaggi e soprattutto della sua opera di docente. In realtà non è un compito facile per la mole e la diversificazione della sua opera scientifica. Questa analisi dovrà essere fatta con maggiore distacco emotivo, per inquadrarla degnamente nel contesto generale della ricerca geobotanica contemporanea di cui, si può ben dire fino da ora senza temere di accondiscendere all'amicizia, fu tra i principali protagonisti.

Penso invece che sia necessario ora parlare della sua umanità, con l'esperienza diretta che con il passare del tempo e dei colleghi e amici, verrà a mancare lasciando al giudizio solo l'obiettività dei fatti. E per una volta

e per un amico, mi si conceda di essere soggettivo e di dire, con molta difficoltà, ciò che Duilio era per me, sperando di trovare qualche condivisione ma non sicuramente completa, perché Duilio Lausi non ebbe una personalità semplice o quantomeno riconducibile ad un paradigma, sebbene di pregio. A me è sempre apparso felicemente complesso: ansioso nelle tappe della ricerca di cui comunicava volentieri le quasi certezze, ma prima ancora i dubbi; aperto ad ogni idea nuova che fornisse un contributo originale, ma cauto di fronte a deviazioni ingiustificate dai metodi dimostratisi utili; disponibile con i giovani, ma severo nel valutare il loro impegno nelle ricerche.

Durante le discussioni scientifiche nelle aule dei convegni o in campagna, assumeva un ruolo inizialmente disposto ad ascoltare, cortese e attento, poi diveniva attivo e vivace interlocutore fino a condurre con arguzia e competenza la discussione. La sua presenza assicurava quella dose di fermento che manteneva elevato il grado di attenzione, dimostrando con molta semplicità che la ricerca, pur basandosi su dati concreti, è soprattutto un processo razionale che richiede e produce cultura.

Mai un viaggio in treno è sembrato troppo veloce e divertente come quando si faceva in sua compagnia. Era un grande estimatore delle ferrovie, non certo per il servizio di cui spesso lamentava la scomodità dei collegamenti con Trieste, ma come mezzo per dedicarsi al lavoro o alla conversazione.

I rapporti con gli allievi del dottorato meritano un cenno particolare: sapeva ascoltarli e non lesinava critiche, ma sempre in termini costruttivi, fornendo indicazioni utili sia per i metodi più adatti sia per le fonti. Ogni argomento posto in discussione era assunto come il più importante e veniva trattato con la massima serietà e approfondimento.

Tra i richiami più frequenti che rivolgeva agli allievi c'era la correttezza del rilevamento di campagna. Ricordo che durante una escursione in Valmalenco nel 1978 di un corso di fitosociologia alpina fece eseguire un rilievo con incremento di superficie su vegetazione di greto, a partire da un piccolo quadrato da 100 cm^2, dimostrando che la struttura della vegetazione da analizzare richiedeva appunto un approccio di quel tipo. Ne uscì un rilievo da manuale che descriveva in modo adeguato l'andamento della curva specie-superficie.

Intese l'insegnamento nel modo più sacrale immaginabile. Per Duilio la responsabilità del maestro era enorme e in molte discussioni sulle vicende che nei nostri anni attraversava l'università emergeva di frequente questo concetto come una sua preoccupazione continua sul dovere di passare le nozioni e soprattutto il comportamento corretto agli allievi. Più di una volta lo sentii esprimere questa idea in termini quasi dinastici: il metodo fitosociologico poteva essere insegnato sul terreno solo da coloro che lo avevano appreso direttamente da Braun-Blanquet o da loro allievi: una sorta di discendenza che garantisse l'aderenza più stretta possibile alla prassi del rilievo della vegetazione, per ridurre il più possibile la inevitabile componente soggettiva implicita nell'applicazione di campionamenti non distruttivi. Il requisito di trasmissione diretta del metodo era certamente una estremizzazione. Da buon biologo sapeva che non si può eliminare la variabilità anche negli operatori, ma la sua indicazione era molto utile per ricordare che corriamo continuamente il rischio di confrontare dati eterogenei.

Da queste posizioni agiva come un conservatore dell'approccio di Braun-Blanquet alla fitosociologia, ma era anche un sostenitore dell'applicazione delle analisi numeriche, raffinato e critico sulla scelta dei metodi e della interpretazione dei risultati, che, affermava, dovevano sempre essere verificati con la realtà.

Disponeva di un'ampia cultura naturalistica, soprattutto ecologica, dimostrando che le delimitazioni delle discipline sono una necessità umana, ma non devono costituire un limite per lo studio della natura.

La sua scomparsa ci ha lasciato un grosso vuoto, in particolare nel corso di dottorato di ricerca in Geobotanica

Augusto Pirola

Studia Geobotanica. Vol. 16: 5-32 (1998).

THE SEGETAL VEGETATION OF VINEYARDS AND CROP FIELDS IN FRIULI-VENEZIA GIULIA (NE ITALY)

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Keywords: crops, Friuli-Venezia Giulia, Italy, segetal vegetation, syntaxonomy, vineyards.

Abstract: The segetal vegetation of vineyards and crop fields of Friuli-Venezia Giulia (NE Italy) was studied. 165 phytosociological relevés were analyzed by numerical classification and compared with those of Central European isoecic coenoses. Four associations were detected: the coenoses of vineyards and of weeded summer cultures of the plain and the hill belts, corresponding to those already described from Central Europe (*Geranio rotundifolii-Allietum vinealis* R. Tx. ex von Rochow 1966 and *Echinochloo-Setarietum pumilae* Felföldy 1942 corr. Mucina 1993, respectively), and the coenoses of weeded cultures of the mountain belt and of winter crop fields, described as new associations (*Galeopsido tetrahit-Galinsogetum* ass. nova and *Papaveretum apuli* ass. nova, respectively). A new subassociation of the *Echinochloo-Setarietum pumilae* is proposed, and the ecological concept of agroform is introduced. The results of this study indicate that the standardization of agronomic techniques has drastically reduced the biodiversity of these associations.

Introduction

The coenoses of vineyards and of crops (maize, soy-bean, potatoes, wheat and barley) are subjected to a very high anthropogenic pressure which changes continuously, due to the transition from artisan and semi-artisan techniques to an industrial agriculture. This has deeply modified the flora and vegetation of agroecosystems. The disappearance of many archaeophytes and the income and stabilisation of many neophytes represent very good examples of this phenomenon (Martini & Poldini 1995).

The standardization of agronomic techniques and the increased use of herbicides have drastically reduced the biodiversity of these ecosystems and the number of thermophilous species has strongly decreased. This is testified, for instance, by the disappearance of some syntaxa such as the *Polygono-Chenopodion polyspermi* alliance, described by Pignatti (1952) from the Venetian plain (Krippelová 1979). For this reason, it is necessary to reconsider the syntaxonomy of relevés from Friuli-Venezia Giulia. Nowadays it may be more appropriate to include them in the isoecic coenosis of Central Europe (*Geranio-Allietum* for vineyards of Rhine valley and *Echinochloo-Setarietum* for weeded crops of Central Europe). As a consequence, these coenoses have a very large distributional range that includes several biogeographical regions with different potential vegetations.

The weed communities of autumn-winter cereals (wheat and barley) and those of cultures of the mountain belt (potatoes and beans) are well differentiated; they are described for the first time in this paper.

When considering the strong floristic homogenization of agroecosystems, we adopted the syntaxonomical scheme proposed by Mucina (1993) that groups all the crop coenoses into a single class (*Stellarietea mediae*), rather than considering the coenosis of autumn-winter crops as belonging to the independent class of *Secalietea* (Oberdorfer 1993).

As already noted for other ecosystems (Chiapella Feoli & Poldini 1993; Poldini & Oriolo 1994), some of the relevés presented in this paper have a documentary value for vanishing plant communities.

Data and methods

165 phytosociological relevés regarding the main cultures of Friuli-Venezia Giulia have been considered. Karst relevés have been taken from Poldini (1989).

The relevés have been compared with those of vineyards of Slovenia (Vipava valley, Seljak 1989) and of Central Europe (Oberdorfer 1993; Wilmanns 1989), and with those of weeded crop fields from Italy [eastern Venetian plain (Lorenzoni 1963) and

Ferrara province (Gerdol & Piccoli 1979)], Slovenia (Vipava valley, Seljak 1989), Germany (Oberdorfer 1993), Croatia (Regula-Bevilacqua 1979) and Slovakia (Krippelová 1981).

Cover values have been converted according to van der Maarel (1979), and numerical data analysis has been carried out with Syn-Tax (Podani 1993) and Lagoli (Lagonegro & Feoli 1985) softwares.

The floristic nomenclature follows Ehrendorfer (1973), and the syntaxonomical one Mucina (1993), who refers to Ries (1992). Ecological indices have been desumed from Landolt (1977) and Poldini (1991). Data concerning pollination mechanisms has been drawn from Faegri & van der Pijl (1971), those concerning dispersion from Müller-Schneider (1986). Life forms and chorotypes have been taken from Poldini (1991).

Abbrevations in the tables are as follows: d = differential species of a part of an association; DAss = differential species of association; DAll = differential species of alliance; DO = differential species of order; O = order species; K = class species.

The concept of agroform

The evolution of cultivation techniques causes fast changes in the floristic composition and in the interspecific relationships within crop coenoses. These may change according to specific modifications of the cultivation techniques (for instance the passage from weeding to mulching) (Wilmanns 1989, 1991). In this respect we define as «agroform» of a crop coenosis the result of ecological modifications caused by agronomic techniques, provided that the connection with the original association is still evident.

In the crop associations of Friuli-Venezia Giulia three agroforms of vineyards (showing a transition from weeding to mulching or to mowing) and one of summer weeded crop fields (showing a very high use of herbicides) have been detected. Their description is given in the following chapters.

Syntaxonomical considerations

In order to define the syntaxonomical scheme of crop and vineyard associations of Friuli-Venezia Giulia, two of the most representative schemes were considered, that of Oberdorfer (1993), and that of Mucina (1993).

The scheme proposed by Oberdorfer (1993) is mainly based on Braun-Blanquet (1936). According to this scheme, crops and ruderal communities with annual cycle are divided into two different classes, *Secalietea* Br.-Bl. 1952 and *Chenopodietea* Br.-Bl. in Br.-Bl. *et al.* 1952. The first class includes associations of autumn-winter cereals (for instance barley and wheat), while the second one includes the other crop coenoses (mainly summer weeded crops and vineyards) in the order *Polygono-Chenopodietalia* (Tx. et Lohm. in Tx. 1950) J. Tx. in Lohm. *et al.* 1962, and the ruderal vegetation with annual cycle in the order *Sisymbrietalia* J. Tx. in Lohm. *et al.* 1962. On the contrary, the scheme proposed by Mucina (1993) refers to Tüxen's modification (Tüxen 1950) of Braun-Blanquet's scheme. It considers a single class, *Stellarietea mediae* R. Tx., Lohm. et Preis. in R. Tx 1950, subdivided in four orders: *Centaureetalia cyani* R. Tx., Lohm. et Preis. in R. Tx. 1950 for cultures of basic soils, *Chenopodietalia albi* R. Tx. (1937) 1950 for cultures of acid soils, *Sisymbrietalia* J. Tx. in Lohm. *et al.* 1962 for ruderal vegetation with annual cycle and, finally, *Eragrostietalia* J. Tx. ex Poli 1966 for cultures and ruderal associations with south-eastern European distribution.

The synthetic table (Tab. 1) highlights a substantial group of species, common to all the coenoses (*Chenopodium album*, *Veronica persica*, *Capsella bursa-pastoris*, *Cirsium arvense*, *Fallopia convolvulus*, *Stellaria media*, *Erigeron annuus*, *Sinapis arvensis*), that can be considered as characteristic of *Stellarietea*. This is in line with the fact that strong changes in agronomic techniques are levelling the floristic differentiation of the crop field associations (a valid example is the vanishing of many archaeophytes in wheat fields). Therefore, we think that Mucina's scheme fits better with the present situation in Friuli-Venezia Giulia, also because the only coenosis of *Centaureetalia* found in Friuli-Venezia Giulia (*Papaveretum apuli*) has a high presence of *Stellarietea* species.

We have introduced some significant changes to the original scheme of Mucina (1993):

a) the definition of *Centaureetalia* and *Chenopodietalia* orders seems to be more linked to the vegetation cycle than to soil characteristics. Therefore the spring-summer developing coenoses of vineyards and of summer weeded fields belong to *Chenopodietalia*, while the only association of autumn-winter cereals (*Papaveretum apuli*) belongs to *Centaureetalia*.

b) we placed the coenosis of Friuli-Venezia Giulia vineyards (*Geranio-Allietum*) into the *Chenopodietalia* order, not into the *Centaureetalia* order.

Tab. 1 - Synthetic table of syntaxonomic units present in Friuli-Venezia Giulia (frequency values).
1 = *Papaveretum apuli*; 2 = *Geranio-Allietum*; 3 = *Echinochloo-Setarietum*, Friuli cool variant;
4 = *Echinochloo-Setarietum*, Friuli warm variant; 5 = *Echinochloo-Setarietum xanthietosum*;
6 = *Echinochloo-Setarietum*, Karst warm variant; 7 = *Echinochloo-Setarietum*, Karst cool variant;
8 = *Galeopsido-Galinsogetum*.

		1	2	3	4	5	6	7	8
	Char. & diff. sp. (DAss1) ass. & all. (*Papaveretum apuli* and *Caucalidion*)								
	Papaver apulum	76							
	Avena fatua	59							
	Valerianella rimosa	35							
	Fumaria vaillantii	12							
	Valerianella eriocarpa	12							
	Ajuga chamaepitys	12							
	Ranunculus arvensis	88	9						
	Legousia speculum-veneris	82	9						
	Consolida regalis	65	6						
DAss1	Chaenorrhinum minus	29		6					
	Valerianella locusta	24	14						
DAss1	Silene vulgaris	47	3	13				8	4
DAss1	Oxalis fontana	41		6					4
	Diff. sp. order (*Centaureetalia*)								
	Centaurea cyanus	71							
	Raphanus raphanistrum	47							
	Buglossoides arvensis	41							
	Papaver argemone	24							
	Lolium temulentum	18							
	Rapistrum rugosum	12							
	Legousia hybrida	12							
DAss2	Anthemis arvensis	59	23						
DAss2	Veronica arvensis	53	31						
DAss2	Cerastium glomeratum	53	66						
	Aphanes arvensis	6	3						
	Arabidopsis thaliana	35	3						
	Papaver rhoeas	100	26					25	
	Fumaria officinalis	82	20					8	
DAss2	Alopecurus myosuroides	65	46					8	
	Myosotis arvensis	47	14						26
	Viola arvensis	47	6	6				8	
	Matricaria chamomilla	29			14				9
	Char. and diff. (DAss2) ass. and all. (*Geranio-Allietum* and *Fumario-Euphorbion*)								
	Calepina irregularis		63						
DAss2	Cerastium tenoreanum		57						
	Muscari racemosum		34						
	Allium vineale		31						
	Ornithogalum umbellatum		23						
	Valerianella carinata		11						
	Geranium rotundifolium		3						
	Thlaspi arvense		3						
DAss2	Crepis taraxacifolia	24	83						
K, Dass2	Lactuca serriola	35	63						
DAss2	Geranium dissectum	6	60						
K, DAss2	Bromus sterilis	24	49						

K, DAss2	Veronica hederifolia	18	34						4
DAss2	Muscari comosum	6	11						
	Char. & diff. sp. (DAss3) ass. (*Echinochloo-Setarietum*)								
K, DAss3	Amaranthus retroflexus	18	9	88	100	100	83	100	4
DAss3	Solanum nigrum			31	86	60	83	67	
d	Hibiscum trionum				14	40	100	17	
	Portulaca oleracea			19	71		33	8	
d	Amaranthus graecizans	6			14		67	50	
d	Bidens tripartita				14	100			39
d	Polygonum lapathifolium				43	100			
K, d	Xanthium italicum	12			14	80			
d	Bidens frondosa	6		6		60			
d	Lycopus europaeus					40			
	Diff. sp. ass. (DAss4) (*Galeopsido-Galinsogetum*)								
DAss4	Galeopsis tetrahit								65
DAss4	Galeopsis speciosa								48
DAss4	Aethusa cynapium								30
K, Dass4	Mentha arvensis	6						8	39
DAss4	Galinsoga ciliata			13					26
K, DAss4	Stachys palustris							25	39
DAss4	Galium aparine	29	9					17	70
	Char. & diff. sp. alleance (DAll3) (*Panico-Setarion*)								
K, DAll3	Digitaria sanguinalis	6	9	75	86	40	100	33	9
O2, DAll3	Setaria pumila	6		100	43	100	83	50	48
DO2, DAll3	Echinochloa crus-galli		9	88	100	100	33	42	13
	Chenopodium polyspermum			63	14	40		50	30
DAll3, d	Galinsoga parviflora	6		100	29			42	74
	Panicum miliaceum						17	8	4
	Char. & diff. sp. order (DO2) (*Chenopodietalia*)								
DO2	Euphorbia helioscopia	18	83	75	43	60	50	83	65
DO2	Sonchus oleraceus	18	49	63	43	60	67	58	74
DO2	Sonchus asper	18	40	19	14	60		50	
DO2	Lamium purpureum	12	37	44				33	57
	Sonchus arvensis		3	6				50	13
	Diplotaxis muralis		26	6			83	42	
	Erodium cicutarium		37				33	17	
	Lamium amplexicaule		14					8	
	Class species (*Stellarietea*)								
	Chenopodium album	94	3	100	100	100	100	92	100
	Veronica persica	76	100	44	29	20	83	67	26
	Capsella bursa-pastoris	76	71	81	14		17	83	74
	Cirsium arvense	29	71	13	29		67	58	43
	Fallopia convolvulus	65	14	38	14		33	83	83
	Polygonum persicaria	82	3	81	100		33	83	96
	Stellaria media	76	97	56			33	67	96
	Conyza canadensis	18	9	6		20	17	8	
	Erigeron annuus	53	37	31	57	60			17
	Senecio vulgaris	29	86		29	20	33	42	
	Vicia sativa (aggr.)	71	77			20	17	17	4
	Anagallis arvensis	76	14	6	14			17	
	Mercurialis annua	18	20	6				42	4
	Sinapis arvensis	41	6				33	33	9

Geranium molle	6	17				17	17	4
Brassica napus	12	20					8	9
Cardamine hirsuta	6	23	6					4
Geranium pusillum		3				17	17	4
Datura stramonium	12				40		8	
Oxalis corniculata	6		13					4
Geranium columbinum		23					8	13
Sherardia arvensis		3				17		4
Setaria viridis						67	42	26
Companions								
Agropyron repens	29	34	13	14	40	67	75	4
Calystegia sepium	94	51	88	57	100	33	42	65
Taraxacum officinale (aggr.)	12	94	63	57	60	67	67	26
Polygonum aviculare (aggr.)	76	3	25	14	60		58	9
Convolvulus arvensis	35	77	25	14		100	83	74
Artemisia vulgaris	24	11	6	43			8	4
Trifolium repens	24	14	31	14			8	17
Trifolium pratense	6	11	25			33	42	17
Daucus carota	29	14	13		20	17		13
Sorghum halepense	59		6	57	40	17	8	
Equisetum arvense	24		13	57	60		17	22
Plantago lanceolata	6	20	6			33	17	
Rumex crispus	18	54	19			17	17	
Plantago major	12	9	13		40		8	
Verbena officinalis	6		6	14	40		8	
Diplotaxis tenuifolia	6		6	14		33	17	
Rorippa sylvestris	29	6	6				8	
Potentilla reptans	18	11		14		33		
Galium mollugo	6	3				17		4
Lolium multiflorum	53	51					8	4
Rumex obtusifolius	18	40					17	4
Medicago lupulina	35		19			17	25	
Leucanthemum vulgare (aggr.)	6	3				17		9
Mentha spicata				14	20	17	8	
Arenaria serpyllifolia	59	20	6					
Arrhenatherum elatius	6	11						4
Glechoma hederacea	6		13					9
Medicago sativa	12	3					8	
Achillea millefolium	6					17		9
Mentha longifolia	71	29		14				
Silene alba	59	6						9
Cynodon dactylon		11	6			17		
Poa annua		46	13					17
Aristolochia clematitis		3				17	17	
Agrostis stolonifera		3	13			17		
Trifolium incarnatum /molinieri		20				17	25	
Leontodon hispidus		3				17	17	
Poa sylvicola	82	57						
Artemisia verlotorum	29	3						
Acalypha virginica			6	14				
Rubus caesius	18			14				
Prunella vulgaris						17		4
Conyza albida	24							
Ranunculus bulbosus		29						
Abutilon teophrasti					20			

Although this attribution is questionable, we wanted to put in evidence that this association lacks archaeophytic species, whereas species typical of weeded crops (*Lamium purpureum*, *Sonchus asper*, etc.) are frequent.

In addition to floristic criteria, we considered also structural (presence of bulbous geophytes), functional (presence of C4 plants) and chorological (presence of adventitious species) parameters for the definition of the coenoses.

Table 2 shows that geophytes reach their maximum value in *Geranio-Allietum*, while the highest values of neophytes and C4 species are found in *Echinochloo-Setarietum*; these two categories change together because most of successful neophytes are C4 plants. From Tab. 2 it is also evident that the vineyard vegetation has a low level of disturbance, as indicated by the scarce participation of neophytes. The dendrogram obtained from the cluster analysis of all relevés (Fig. 1) shows four main clusters, as follows:

Table 2 - Parameters used in the definition of coenoses (A = *Papaveretum apuli*; B = *Geranio-Allietum*; C = *Echinochloo-Setarietum*; D = *Galeopsido-Galinsogetum*). Values are weighed by frequency.

	A	B	C	D
Bulbous geophytes	0.001	0.038	0	0
Neophytes	0.082	0.005	0.180	0.085
C4 species	0.026	0.010	0.215	0.058

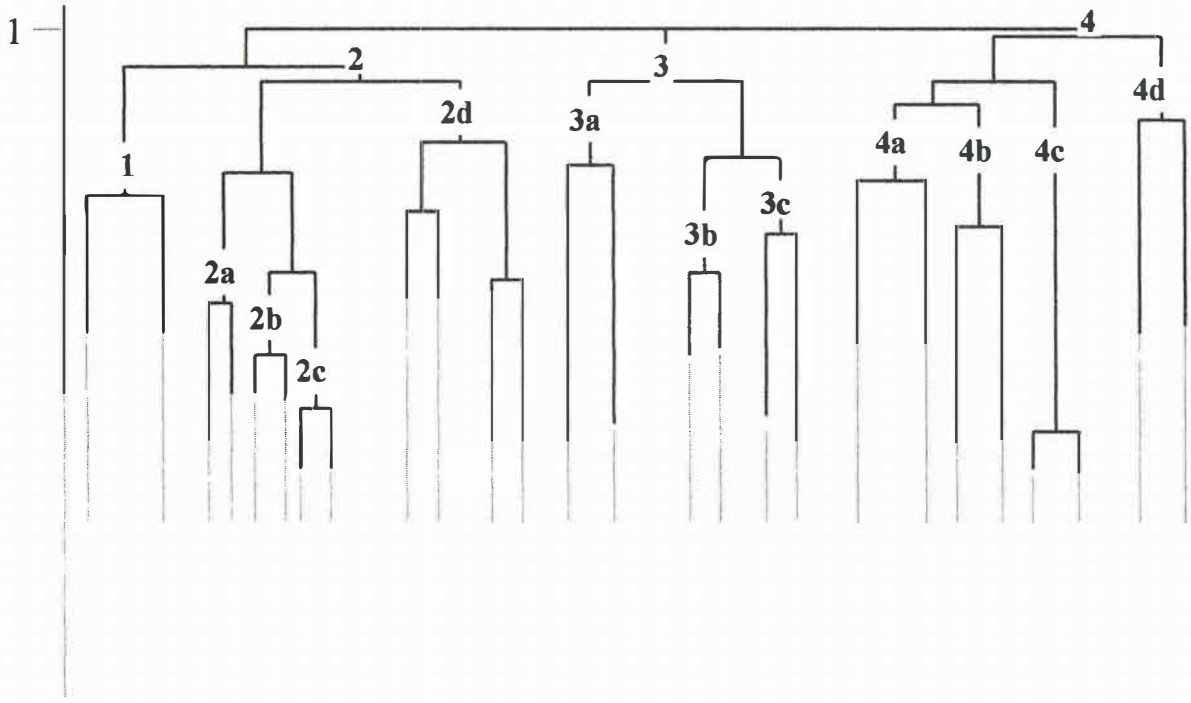

Fig. 1 – Simplified dendrogram of 165 phytosociological relevés (similarity ratio, complete linkage). 1 = relevés of autumn-winter crops (*Papaveretum apuli*); 2 = relevés of summer weeded crops of hills, valley bottoms, and plains; 2a = *Echinochloo-Setarietum*, Friulian cool variant; 2b = *Echinochloo-Setarietum*, Friulian warm variant; 2c = *Echinochloo-Setarietum xanthietosum*; 2d = *Echinochloo-Setarietum*, *Sorghum halepense* agroform; 3a = *Galeopsido-Galinsoghetum*; 3b = *Echinochloo-Setarietum*, Karstic cool variant; 3c = *Echinochloo-Setarietum*, Karstic warm variant; 4 = relevés of vineyards (*Geranium-Allietum*); 4a = *Geranio-Allietum*, typical form; 4b = *Geranio-Allietum*, *Taraxacum officinale* agroform; 4c = *Geranio-Allietum*, *Arrhenatherum elatius* agroform; 4d = *Geranio-Allietum*, *Agrostis stolonifera* agroform.

cluster 1 = relevés of autumn-winter cereals (*Papaveretum apuli*);
cluster 2 = relevés of weeded summer cultures of hills, valley bottoms and plain;
cluster 3 = relevés of weeded summer cultures of Karst and mountains;
cluster 4 = relevés of vineyards (*Geranio-Allietum*).

By following ecological and biogeographical considerations, relevés of cluster 2 can be ascribed to a Friuli sub-race of *Echinochloo-Setarietum*; these relevés can be further subdivided into a cool variant (cluster 2a), a warm variant (cluster 2b), a subassociation (cluster 2c, *xanthietosum*) and an agroform (cluster 2d). Similarly, relevés of cluster 3 can be ascribed to a Karstic sub-race of *Echinochloo-Setarietum*, with a warm variant (cluster 3c) and a cool one (cluster 3b), and to *Galeopsido-Galinsogetum* (cluster 3a). Cluster 4 groups all relevés of vineyards.

The synthetic table of all relevés belonging to clusters 2a,b,c,d and 3a,b,c is reported in Tab. 3. This matrix has undergone a hierarchical classification based on the complete link method, in order to clarify the syntaxonomy of weeded crop fields. The dendrogram is reported in Fig. 2.

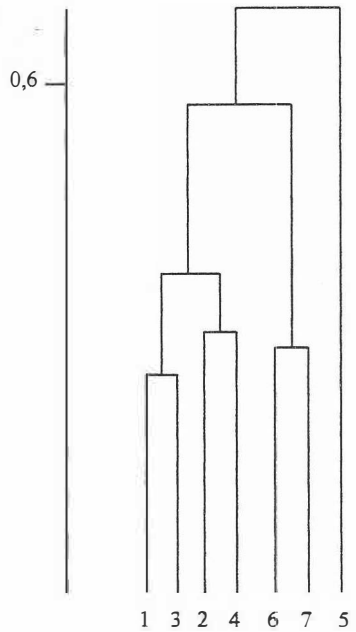

Fig. 2 – Dendrogram of weeded crop coenoses of Friuli – Venezia Giulia (similarity ratio, complete linkage). 1 = *Echinochloo-Setarietum*, Friulian cool variant; 2 = *Echinochloo-Setarietum*, Friulian warm variant; 3 = *Echinochloo-Setarietum xanthietosum*; 4 = *Echinochloo-Setarietum, Sorghum halepense* agroform; 5 = *Galeopsido-Galinsoghetum*; 6 = *Echinochloo-Setarietum*, Karstic cool variant; 7 = *Echinochloo-Setarietum*, Karstic warm variant.

Synoptic table of studied vegetation types

STELLARIETEA MEDIAE R. Tx., Lohm. et Preis. in R. Tx. 1950

CHENOPODIETALIA ALBI R. Tx. (1937) 1950

Veronico-Euphorbion Sissingh ex Passarge 1964 (syntax. syn.: ***Fumario-Euphorbion*** T. Müller in Görs 1966)

1) *Geranio rotundifolii-Allietum vineale* R. Tx. ex von Rochow 1951 (syntax. syn.: *Cerastio-Geranietum dissecti* Poldini 1980)

Panico-Setarion Sissingh in Westhoff *et al.* 1946

2) *Echinochloo-Setarietum pumilae* Felföldy 1942 corr. Mucina 1993 (syntax. syn.: *Panico-Polygonetum persicariae* Pignatti 1953; *Hibisco-Digitarietum sanguinalis* Poldini 1980; *Hibisco-Sorghetum halepensis* Poldini 1989 non Horvatic et Hodak 1960; *Oxalido - Chenopodietum* Sissingh 1950)
subass. *xanthietosum italici* subass. nova hoc loco

3) *Galeopsido tetrahit-Galinsogetum parviflorae* ass. nova hoc loco

CENTAUREETALIA CYANI R. Tx., Lohm. et Preis. in R. Tx. 1950

Caucalidion lappulae (R. Tx. 1950) von Rochow 1951

4) *Papaveretum apuli* ass. nova hoc loco

Associations

Ass.: ***Geranio rotundifolii-Allietum vineale*** R. Tx. ex von Rochow 1951 geogr. var. with *Cerastium tenoreanum*, geogr. var. nova hoc loco (Tab. 4).
Syntax. syn.: *Cerastio-Geranietum dissecti* Poldini 1980.
"The vegetation of vineyards"

Tab. 3 - Simplified comparison table of weeded coenosis of Friuli-Venezia Giulia (frequency values). 1 = *Echinochloo-Setarietum*, Friulian cool variant; 2 = *Echinochloo-Setarietum*, Friulian warm variant; 3 = *Echinochloo-Setarietum xanthietosum*; 4 = *Echinochloo-Setarietum, Sorghum halepense* agroform; 5 = *Echinochloo-Setarietum*, Karstic warm variant; 6 = *Echinochloo-Setarietum*, Karstic cool variant; 7 = *Galeopsido-Galinsogetum.*

		1	2	3	4	5	6	7
	Charac. and diff. (DAss1) species of ass. (*Echinochloo-Setarietum*)							
K,DAss1	Amaranthus retroflexus	88	100	100	91	83	100	4
DAss1	Solanum nigrum	31	86	60	78	83	67	
	Portulaca oleracea	19	71		5	33	8	
d2	Hibiscum trionum		14	40	5	100	17	
d2	Bidens tripartita		14	100	5			39
d2	Amaranthus graecizans		14			67	50	
d2	Bidens frondosa	6		60				
d2	Polygonum lapathifolium		43	100				
d2	Xanthium italicum		14	80				
d2	Lycopus europaeus			40				
	Charac. and diff. (DAss2) species of ass. (*Galeopsido-Galinsogetum*)							
DAss2	Galinsoga ciliata	13			5			26
DAss2	Galium aparine						17	70
K, Dass2	Mentha arvensis						8	39
K, DAss2	Stachys palustris						25	39
DAss2	Galeopsis speciosa							48
DAss2	Galeopsis tetrahit							65
DAss2	Aethusa cynapium							30
	Charac. and diff. (DAll) of all. (*Panico-Setarion*)							
K, Dall	Digitaria sanguinalis	75	86	40	82	100	33	9
DO, DAll	Echinochloa crus-galli	88	100	100	22	33	42	13
Dall	Setaria pumila	100	43	100	48	83	50	48
	Chenopodium polyspermum	63	14	40	8		50	30
DAll, DAss2	Galinsoga parviflora	100	29		73		42	74
	Panicum miliaceum					17	8	4
	Charac. and diff. (DO) species of ord. (*Chenopodietalia*)							
DO	Euphorbia helioscopia	75	43	60	49	50	83	65
DO	Sonchus oleraceus	63	43	60	22	67	58	74
DO	Sonchus asper	19	14	60	13		50	
DO	Lamium purpureum	44			9		33	57
	Diplotaxis muralis	6				83	42	
	Sonchus arvensis	6					50	13
	Erodium cicutarium					33	17	

Class species (*Stellarietea*)							
Chenopodium album	100	100	100	73	100	92	100
Veronica persica	44	29	20	26	83	67	26
Cirsium arvense	13	29		13	67	58	43
Capsella bursa-pastoris	81	14		59	17	83	74
Fallopia convolvulus	38	14		5	33	83	83
Polygonum persicaria	81	100		91	33	83	96
Erigeron annuus	31	57	60	30			17
Conyza canadensis	6		20	8	17	8	
Stellaria media	56			21	33	67	96
Senecio vulgaris		29	20	23	33	42	
Vicia sativa (aggr.)			20	5	17	17	4
Mercurialis annua	6			40		42	4
Geranium molle				5	17	17	4
Setaria viridis				14	67	42	26
Sinapis arvensis				5	33	33	9
Datura stramonium			40	18		8	
Papaver rhoeas						25	
Myosotis arvensis							26
Companions							
Agropyron repens	13	14	40	26	67	75	4
Calystegia sepium	88	57	100	87	33	42	65
Taraxacum officinale (aggr.)	63	57	60	22	67	67	26
Sorghum halepense	6	57	40	57	17	8	
Equisetum arvense	13	57	60	17		17	22
Polygonum aviculare	25	14	60	22		58	9
Convolvulus arvensis	25	14		52	100	83	74
Ranunculus repens	38		20	38	17	17	22
Diplotaxis tenuifolia	6	14		5	33	17	
Artemisia vulgaris	6	43		14		8	4
Trifolium repens	31	14		8		8	17
Daucus carota	13		20	9	17		13
Plantago major	13		40	5		8	
Mentha spicata		14	20	9	17	8	
Verbena officinalis	6	14	40			8	
Medicago lupulina	19			9	17	25	
Rumex crispus	19			5	17	17	
Trifolium pratense	25				33	42	17
Cynodon dactylon	6			27	17		
Plantago lanceolata	6				33	17	
Lythrum salicaria		14	20	5			
Potentilla reptans		14		9	33		
Trifolium incarnatum/molinieri					17	25	
Abutilon theophrasti			20				

Tab. 4 - *Geranio rotundifolii-Allietum vineale* R. Tx. ex von Rochow 1951 geogr. var. with *Cerastium tenoreanum* var. nova hoc loco

	Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
	Altitude (x 10 m)	14	3	30	19	5	52	19	23	19	22	23	18	31	12	17	19	2	2	2	2	2	2	2	5	3	3	2	6	3	5	3
	Exposure							SO		NW			S																S		E	
	Slope (°)							10		20			10																20		20	
	Number of species (sporadic included)	28	21	25	27	34	17	25	35	25	28	28	23	32	17	31	48	42	41	31	33	30	27	26	23	19	26	32	24	26	25	29
																	typical form															
	Charac. and diff. (DAss) spec. of ass. and all. (*Fumario-Euphorbion*)																															
DAss	Geranium dissectum									1	+	+	+		1		+	1	+	+	+	+	1	+	r		2	1	3	+		
DAss K	Lactuca serriola		+			+		1	+							+	1	+		+	+		+	1	+	+	+	+	+	+	+	+
	Allium vineale					+			+	+		+					+	+	+										+	+		
DAss K	Bromus sterilis					2		1	2	2	3	1	3	3					2				1	+		+	2			+	+	
	Muscari racemosum				+				+		+						+		+						r				r		+	
DAss K	Veronica hederifolia	2	r	1		+		1	1	+		1	+	+					+													
DAss K	Veronica arvensis	+				+			+	+							+	+	r									1				
	Ornithogalum umbellatum									+					2		+		+		+							r				
DAss.	Fumaria officinalis	1					2										+		r	+												
DAss K	Anthemis arvensis															+	1		1					+				+				+
DAss	Valerianella locusta																+		1					1			1	1				
DAss	Muscari comosum	+															+	+														
	Valerianella carinata								+	2											+	+										
	Thlaspi arvense			1																												
	Geranium rotundifolium (Gagea villosa)																															
	Diff. spec. SE-alpine race																															
DAss	Crepis taraxacifolia	+	+	1			+	+	+	1	1	1	1	1	+	+	1	+	r	+	+		+		+		+	+	r	+	+	+
	Poa sylvicola	+			+				+			+				2	+	1	+	1	+	1	1	+			1	+		1	+	
	Rumex obtusifolius	+														1	+	+						+	r	+	+	+		+		1
	Vicia sativa (aggr.)	+			+	+		1	1	1	+	+		+		+	1	+	1	+	+		+	+	+	1	1	1			r	+
DAss	Cerastium glomeratum	+	+						+					+		+	+	+	+	+	+	1	+	+	+	1	1	1		+	1	1
	Lolium multiflorum		1	1	2	1					1	1	1					1	1						+	+		+	+	+	+	
	Rumex crispus			1	+			1	1	1	1	1	2	1		1	1	+	1	1	1	+	1	+								
d	Calepina irregularis				2				3	1	3	3	3	3	2					2	3	2	3	1	2	3	2	2	2	3	1	2
DAss	Cerastium tenoreanum	+				1			+	+	+			+					+	2	1	+		+	+	1	+	+	1	+		+
DAss	Alopecurus myosuroides					1											2	1		1		2	+	3	3	2	+	1		+		1
	Charac. and diff. (DO) spec. of ord. (*Chenopodietalia*)																															
DO	Euphorbia helioscopia		1	+	+		+	+	1		+	+		+			1	1	1	1	1	+	2	2	1	1	+	1	1	1	+	2
DO	Lamium purpureum			1					+	+	+		+		+		+		+				+				+					
DO	Sonchus oleraceus				+	+		+							+		+		r			1			+	+		+	+		+	+
DO	Sonchus asper		r															+		+	+	+					+	+	+	1	+	+
	Erodium cicutarium		+		+	1			+				+					+				+	+				1	+	1			1
	Diplotaxis muralis		+	+		+								+				+			+		+								+	
	Lamium amplexicaule						+	2			+	+											+									
	Echinochloa crus-galli											1				1	1															
	Digitaria sanguinalis																1				1											
	Amaranthus retroflexus																									+	+					+
	Sonchus arvensis																+															
	Class spec. (*Stellarietea*)																															
	Veronica persica	3	3	1	3	3	2	1	3	3	3	3	3	2	2	2	2	1	1	1	2	+	2	1	1	2	3	2	2	1	2	1
	Stellaria media	3	2	+	4	2	3	4	3	3	2	3	3	2	3	2	2	1	+	1	2	2	1	1	+		+	1	2	1	+	+
	Senecio vulgaris	+	r	+	+	1	1	+	+	+	+	+	+	+		+	1	+	r	1	+	2	+	r	r				+	+	r	+
	Cirsium arvense			2	2	1	2	1	1				1	1	1	2	1	2	1	2	1	2		+	1	1		1		1	1	+
	Capsella bursa-pastoris	+	1	+	+	1	1	1	+		+			+	+	1	1	+	r	+	2	+						+		+	r	+
	Erigeron annuus		+			+	+									+		+		+		+					+	1	+	+		+
	Cardamine hirsuta			1							+		+	+						+	+			r						+		
	Papaver rhoeas	+															+	+	r			+	+									r
	Geranium molle		r																1							r		+				
	Geranium columbinum				+	+		+	+		+						+															
	Brassica napus	+	+																		+			+			+	r				+
	Mercurialis annua				+												+											r	+		+	
	Bromus hordeaceus								+					+							+											
	Myosotis arvensis			+	+	+					+													+								
	Fallopia convolvulus	+				+	+	+				+																				
	Anagallis arvensis	+											+			+	+				+											
	Conyza canadensis					+		+									+															

Tab. 4 – Continued.

32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	Typical associat.			Total	
5	15	17	18	1	15	13	2	2	24	2	2	24	3	12	13	13	11	12	13	5	2	2	1	2	1	26	25	24	2	2					
					S							S	W							S															
					5							20	10							15															
26	30	41	26	23	33	32	14	19	18	32	26	30	18	18	18	19	17	21	19	25	18	28	21	28	32	38	24	27	21	21					
					Taraxacum officinale agroform								*Arrhenatherum elatius* agroform							*Agrostis stolonifera* agroform													Pr.	Fr.	Cl.	Pr.	Fr.
1	r	1		3	1				2	r	+	1								+	1				+							21	58	IV	30	48
+	+	+		+								+																				22	61	V	24	39
	+		+		+	2			1		+	+								2	3	+			2	+	2					11	31	II	22	35
		1	+					r												+										+		17	47	III	20	32
r	+	+	+			2														+		+		+	1							12	33	II	17	27
r					+	+																	+			r						12	33	II	16	26
	+	+	r	1																						r	+					11	31	II	14	23
		+	r	1		2																1						+				8	22	II	12	19
	+	r			+																											7	19	I	8	13
		1	2																													8	22	II	8	13
																																5	14	I	5	8
		1																														4	11	I	4	6
																																4	11	I	4	6
																																1	3	I	1	2
			3																													1	3	I	1	2
1	+	1				1		r	1	r		+									+	r			+	1	+					29	81	V	39	63
+		+	+	2	2	1	1	2	2	2	1	1								1		2	3	2	2	3	1	1				20	56	III	37	60
+		+	+				1	1	+		+	+	1	1	1	+	+	1	+	1	+	+	1	+		+		+		1		14	39	II	34	55
+	+	+	1		+																+			+	+	1						27	75	IV	32	52
+	+	+		3		+		1	+	1										+					+	1	r					23	64	IV	32	52
	1	2	2				+	1	1	1	+	1									+	1	1		1	1		2				18	50	III	30	48
	+				1					+																	+		+			19	53	III	23	37
	1																															22	61	IV	22	35
	2	+																		+												20	56	III	21	34
+	2	3							1		+																					16	44	III	18	29
1	1	1	+	1	+	+					+	+										+			r	r			r			29	81	V	38	61
+	+	+		2	1	1	1	+	+	+	+	+	+	+	+			1			+	1	1	1	+	+						13	36	II	32	52
+	+	+	+		+	+			+	1		r									+			1								17	47	III	24	39
1		+	r				+			r	+	+														+						14	39	II	19	31
	1																															13	36	II	13	21
		+																														9	25	II	9	15
																																5	14	I	5	8
					1																											3	8	I	4	6
		r																														3	8	I	3	5
																																3	8	I	3	5
																																1	3	I	1	2
1	1	1	1	2	1	1	1		+	1	1	2			1	+		+	+	1	+	+	1	1	1	+			+			35	97	V	55	89
1	+	+	+	1	3	1	2	1	+	+		1	1	+	1	1	+			+			2	1		+		+				34	94	V	52	84
+	r	+		+	1		1	+	+	r		+								+												30	83	V	38	61
+		r			+	+				+	+																				1	25	69	IV	30	48
+	r	+			+	1		r		+																						25	69	IV	29	47
	+				1	1	+	+		r	+									1			+		+	1	+	+				13	36	II	25	40
										+														+	+	r						8	22	II	12	19
	1	r																								r						9	25	II	10	16
+	r			1																		1	+	+								6	17	I	10	16
		1	+			+						+																				8	22	II	10	16
					1																											7	19	I	8	13
	+		+																													7	19	I	7	11
				1																+						1		+				3	8	I	7	11
				+																												5	14	I	6	10
					+																											5	14	I	6	10
																																5	14	I	5	8
						+																										3	8	I	4	6

Tab. 4 – Continued.

	Geranium pusillum										+																			
	Ranunculus arvensis	+		+													+													
	Legousia speculum-veneris	+				+																								
	Malva neglecta															+						2								
	Sherardia arvensis																	r												
	Solanum nigrum																													
	Aphanes arvensis																	+												
	Consolida regalis	1																				+								
	Sinapis arvensis	1		+																										
	Viola arvensis					1												r												
	Chenopodium album																													
	Polygonum persicaria														+															
	Differerential spec. of agroform							+																						
	Plantago major										+		+				+													
	Trifolium pratense								+		+																			r
	Trifolium repens														+		+	+		+						r				
	Lolium perenne								+																					
	Diff. spec. of *Agrostis stolonifera* agroform																													
	Potentilla reptans							+			1		1		+															
	Ranunculus repens									+	+						+													
	Agrostis stolonifera																												+	
	Bellis perennis																										+			
	Cerastium holosteoides																													
	Dactylis glomerata																													
	Rumex acetosella																													
	Diff. spec. of *Arrhenath. elatius* agroform																													
	Plantago lanceolata			+	+	+				+		+					+										+			
	Arrhenatherum elatius								1	1								+	+											
	Silene alba					+										+														
	Galium mollugo																	+												
	Achillea millefolium																													
	Prunella vulgaris																													
DO	Setaria pumila																													
	Geranium pyrenaicum																													
	Companions																													
	Taraxacum officinale (aggr.)		+	1	+	+	+		1	1	1	2	2	1	+	+	+	+	+	+	+	+	+	+		+	+	+	1	+	+
	Convolvulus arvensis	1	r	1	1	1	1			+	+	+	1	1	+	2	2	2	+	+	1	2	1	+	+	+				+	
	Agropyron repens	+														3	3	1	2		1	1			+			+		1	1
	Poa annua		1			+			1	3		1	3	1	+			1					+		1	+				2	3	3
	Calystegia sepium	+	+				+	+	+	+	+		+			1	1	1	+	1	1	1				+		+			
	Ranunculus bulbosus			+	+	1		+	+	1		+	+	+	+																
	Mentha longifolia								1							1	1	+	+	1	+	+									+

Charact. and diff. (D) species: *Allium vineale*, *Cerastium tenoreanum* (D), *Geranium dissectum* (D), *Crepis taraxacifolia* (D), *Calepina irregularis*, *Geranium rotundifolium*, *Muscari comosum* (D), *M. racemosum*, *Ornithogalum umbellatum*, *Valerianella carinata*, *Cerastium glomeratum* (D), *Thlaspi arvense*, *Lactuca serriola* (D), *Veronica hederifolia* (D), *Bromus sterilis* (D) and *Gagea villosa* (very rare in Friuli-Venezia Giulia). Moreover, it is possible to consider as differential species *Alopecurus myosuroides*, *Fumaria officinalis*, *Valerianella locusta*, *Anthemis arvensis* and *Veronica arvensis*, which derive from *Centaureetalia* (because of similar growth time).

Floristic composition. This is the agrocoenosis with the highest number of bulbous geophytes (*Allium vineale*, *Muscari racemosum*, *M. comosum* and *Ornithogalum umbellatum*), because of the absence of tilling works until late spring. For the same reason this association is particularly rich in spring therophytes, such as *Geranium dissectum* (which can form thick carpets), *G. molle*, *G. rotundifolium*, *G. columbinum*, *G. pusillum*, *Cerastium tenoreanum* and *C. glomeratum*. *Stellaria media* and *Veronica persica* are always present with the highest cover values, while *Calepina irregularis* is sometimes absent, whereas sometimes it dominates the relevés.

Syntaxonomy. The vegetation of vineyards of Karst and Collio was described by Poldini (1980, 1989) with the name of *Cerastio-Geranietum dissecti*. At that time the author had already put in evidence the strong differentiation from the isoecic coenosis of

Tab. 4 – Continued.

				1	+	3																									1	3	I	4	6	I
																															3	8	I	3	5	I
	+																														3	8	I	3	5	I
						2																									2	6	I	3	5	I
						+																							r		1	3	I	3	5	I
															+	+		+													0	0		3	5	I
						+																				+					1	3	I	3	5	I
																															2	6	I	2	3	I
																															2	6	I	2	3	I
																															2	6	I	2	3	I
																		+													1	3	I	2	3	I
																															1	3	I	1	2	I
					+			+	+	+	+			1	+		+	+	+			+			+	+	+		+	r	3	8	I	19	31	II
+						1			+				+					+	1		+		+	+	+	1	1	+		+	4	11	I	17	27	II
					+			+		+	1	1		+			+			2		1	+								5	14	I	15	24	II
										1				+	+	1	+	+	+			1		+	1				2		2	6	I	13	21	II
+					1					+	1	1								+	2	1	+	+	+	+		1	1	3	4	11	I	18	29	II
					1	+		+		+	1	1									+	r	+			+	1	1	2	3	3	8	I	17	27	II
										2	1	+								2	1	2	1	3	1	1	3	2	3		1	3	I	14	23	II
				3			+			r	+									+	+	+	1	+	+						1	3	I	11	18	I
						+		+																+	+	+	r	+			0	0		7	11	I
										r	+											+				r		+	+	+	0	0		7	11	I
																										1	+	1			0	0		3	5	I
				1	+	+							1	2	2	2	1	1	1	1	+			+	+	+	+	+			7	19	I	24	39	II
											+		4	4	4	4	4	3	2	r				1	1	+	+	2			4	11	I	18	29	II
													+	1	1	1	+	+	1					+		+					2	6	I	11	18	I
													2	2	1	1		1	1			+			+		+	2			1	3	I	11	18	I
						1							1		1	2	2	2	2						+		+	1			0	0		10	16	I
													+	+	1	2	1	1							1				+		0	0		8	13	I
													1	1	1	2	1	1	1												0	0		7	11	I
													+	1	1	1			+												0	0		5	8	I
+	+	r	r	1	1	4	2	1	2	1	1	2	+	+	2	1	1	1	3	1	1	2	2	2	+	1			+	+	33	92	V	58	94	V
		+	+			+						+	1	1		2	1	1	1												27	75	IV	35	56	III
+										+		r								1			+	+	1	1	2	+		1	12	33	II	22	35	II
				1			1	1	1	1	1									+											16	44	III	23	37	II
	+	+								+																+				+	18	50	III	21	34	II
				1									1	+			+		+			r		+							10	28	II	17	27	II
			+							+		+										+		1	+						10	28	II	15	24	II

Central Europe (*Geranio-Allietum*). In this respect, we faced the problem of differentiating between geographical race and association. Data analysis is not useful to detect the shifting point between these two *syntaxa*, and it is therefore necessary to evaluate both the biogeography and the potential vegetation of the survey area (Poldini *et al.* 1996). The potential vegetation (as synonym of the synphytosociological term «head association») of Friuli-Venezia Giulia is represented by mature oaks woods: *Seslerio-Quercetum petraeae* (Poldini 1964 n.n.) Poldini 1982, *Carici umbrosae-Quercetum petraeae* Poldini ex Marincek 1994, *Asparago tenuifolii-Quercetum roboris* (Lausi 1966) Marincek 1994 (basionym: *Querco-Carpinetum boreo-italicum* Pignatti ex Lausi 1966). These woods are particularly rich in species with submediterrenean - SE European distribution. Such a strong characterization could suggest that the coenosis of Friuli-Venezia Giulia vineyards belongs to an independent association. Nevertheless, we observed that, when anthropogenic pressure is very high, the same association («tail association») develops from different head associations (Géhu 1996).

Table 5 shows the main differences between the vineyard vegetation of Friuli-Venezia Giulia and that of Central Europe. The community occurring in Friuli-Venezia Giulia is characterized by several thermophilous elements, such as *Alopecurus myosuroides, Calepina irregularis, Calystegia sepium, Cerastium tenoreanum, Crepis taraxacifolia, Geranium dissectum, Poa sylvicola, Rumex*

Tab. 5 – Simplified, synthetic table of Centro-European *Geranio-Allietum* and of the SE-Alpine race (frequency values). A = data from Oberdorfer (1993); B = data from Wilmanns (1989); C = data from Tab. 4.

	A	B	C
Species of ass. and all. (*Veronico-Euphorbion*)			
Allium vineale	70	75	40
Bromus sterilis	20	50	53
Fumaria officinalis	54	25	18
Geranium rotundifolium	21	44	8
Lactuca serriola	22	75	60
Muscari racemosum	51	56	35
Ornithogalum umbellatum	23	31	28
Valerianella carinata	2	13	10
Veronica arvensis	13	25	28
Cerastium glomeratum	4		60
Gagea villosa	16	13	
Geranium dissectum	17		63
Thlaspi arvense	6		5
Veronica hederifolia		88	33
Allium oleraceum	14		
Allium scordoprasum		13	
Alopecuros myosuroides			40
Anthemis arvensis			20
Calepina irregularis			55
Cerastium tenoreanum			58
Crepis taraxacifolia			78
Lolium multiflorum			45
Muscari comosum			10
Poa sylvicola			50
Valerianella locusta			13
Ord. (*Chenopodietalia*) species			
Euphorbia helioscopia	78	19	80
Lamium amplexicaule	30	6	18
Lamium purpureum	89	100	33
Solanum nigrum	61	13	10
Sonchus arvensis	15	6	5
Sonchus asper	81	19	38
Sonchus oleraceus	91	19	48
Echinochloa crus-galli	27		10
Erodium cicutarium	29		40
Euphorbia peplus	33		
Class (*Stellarietea*) species			
Amaranthus retroflexus	19	19	15
Capsella bursa-pastoris	25	13	75
Chenopodium album	35	19	10
Cirsium arvense	56	38	68
Conyza canadensis	13	19	8
Geranium pusillum	11	13	3
Mercurialis annua	52	81	23
Papaver rhoeas	9	6	28
Senecio vulgaris	84	56	85
Stellaria media	80	88	98
Veronica persica	64	94	100
Anagallis arvensis	16		18
Fallopia convolvulus	1		18
Geranium columbinum	15		20
Malva neglecta	17		5
Setaria viridis	21		8
Sinapis arvensis	20		5
Cardamine hirsuta		31	20
Vicia sativa (aggr.)		19	75
Brassica napus			18
Diplotaxis muralis			25
Erigeron annuus			33
Companions			
Agropyron repens	41	25	38
Convolvulus arvensis	41	69	80
Galium aparine	10	25	8
Lolium perenne	4	25	5
Poa annua	22	69	40
Polygonum aviculare (aggr.)	15	19	3
Taraxacum officinale	91	94	88
Diplotaxis tenuifolia	1	25	
Lapsana communis	14		3
Ranunculus repens	26		13
Veronica polita	58	6	
Calystegia sepium			48
Mentha longifolia			25
Ranunculus bulbosus			25
Rumex crispus			48
Rumex obtusifolius			35
Trifolium incarnatum/molinieri			23

crispus, and *Vicia sativa / angustifolia.* With the exception of *Calepina irregularis,* these species are not exclusive of vineyards, but penetrate from surrounding habitats. They can be considered as the geographical differentials of a Southeastern Alpine race of *Geranio-Allietum.* The ecological-structural meaning of the high frequency of spring bulbous geophytes, which distinguishes this agrocoenosis from the others, has been considered particularly important and has led us to include the relevés of Friuli-Venezia Giulia into *Geranio-Allietum.*

At higher syntaxonomical levels, the attribution of this coenosis is evident; *Geranium dissectum* and *Fumaria officinalis* show adherence to the alliance *Veronico-Euphorbion.* Since *Geranio-Allietum* is the only known association of this alliance in Friuli-Venezia Giulia, alliance and association species coincide. *Sonchus oleraceus, S. asper, Euphorbia helioscopia, Lamium purpureum, L. amplexicaule, Diplotaxis muralis* and *Erodium cicutarium* show adherence to *Chenopodietalia.*

Centaureetalia species are particularly frequent in these relevés. This depends on the growth time of *Geranio-Allietum* (spring) when also the autumn-winter cultures have their maximum blooming. *Stellarietea* species are very numerous. Among them, *Veronica persica, Stellaria media, Senecio vulgaris, Cirsium arvense, Capsella bursa-pastoris* and *Erigeron annuus* are the most frequent.

Variability. It is low, although the relevés come from areas with strong pedological differences (karstic «terre rosse», flysch and gravels). A certain differentiation (floristic rather than ecological) exists between relevés of the Collio hills near Gorizia (*Alopecurus myosuroides*) and those from the Karst plateau near Trieste (*Ranunculus bulbosus* and *Trifolium incarnatum/molinieri*, maybe once used as fodder plants).

Agroforms. The variety of cultivation techniques in viticulture has a strong influence on vineyard coenoses. It is therefore possible to identify three agroforms that are often more frequent than the typical association.

— *Taraxacum officinale* agroform (Tab. 4, rels. 36-44): it occurs in vineyards characterized by light tilling once or twice a year, combined with mulching between the rows and the use of desiccatives beneath the rows. Sometimes *Taraxacum officinale* dominates these vineyards, because its roots, rich of reserve material and buds, make it resistant to mulching and tolerant to the use of desiccatives and to occasional tap-root fragmentation caused by harrowing, which may even foster its propagation (Wilmanns 1991). In this agroform all species of *Geranio-Allietum* are well represented, especially *Geranium dissectum.*

— *Agrostis stolonifera* agroform: it occurs in vineyards characterized by the absence of tilling (Tab. 4, rels. 52-62); it spreads on heavy clay soils with high water table, such as those of the springs area («risorgive»). The weeds control is made by mulching, which helps the spreading of creeping perennial herbs (*Potentilla reptans, Agrostis stolonifera* and *Ranunculus repens*, etc.) or of plants with tap-roots (*Taraxacum officinale*). Among the differential species of *Geranio-Allietum, Allium vineale* reaches high cover values, because, in absence of tilling, it forms large tufts.

— *Arrhenatherum elatius* agroform (Tab. 4, rels. 45-51): it occurs in vineyards where soil tilling is replaced by mowing and natural manuring. Besides *Arrhenatherum elatius*, other species of *Arrhenatherion* dominate this agroform, such as *Galium mollugo, Silene alba* and *Plantago lanceolata.* Therefore, the characteristic species of vineyards almost disappear, being replaced by perennial herbs.

The two first agroforms correspond to those described by Wilmanns (1989, 1991) from the Rhine valley.

Life forms. This association, in its typical aspect, shows a high percentage of geophytes (11.3%), although therophytes dominate (67.0%) and the percentage of hemicryptophytes is also high (21.4%). The increase in hemicryptophytes in the agroforms is caused by the reduction of soil tilling, replaced by mowing and the use of desiccatives.

Chorotypes. The low percentage of adventitious species is noteworthy; this fact confirms that vineyards are scarcely disturbed cultures. The high percentage of euromediterranean species (26.6%) and the presence of stenomediterranean ones (0.6%) well arrange with the Mediterranean gravitation of the SE-Alpine race of *Geranio-Allietum*; these chorotypes decrease in agroforms where species with European distribution (more resistant to disturbance) prevail.

Pollination and dispersal. There are some differences between the typical association and its agroforms. Autogamy and entomophily are progressively substituted by anemophily, proceeding from the association to its agroforms. In *Geranio-Allietum*, due to ground tilling, autogamy is very important; in fact this strategy guarantees quick self-fecundation of species (Faegri & van der Pijl 1971)

and fructification before the next tilling. In the agroforms with *Agrostis stolonifera* and *Arrhenatherum elatius* the mowing favours the spreading of anemophilous *Gramineae*. The agroform with *Taraxacum officinale* is a transition coenosis, because of the co-presence of tilling and mulching.

Sinecology. The coenosis develops at the beginning of spring in vineyards where artisan cultivation techniques are used. The absence of tilling until late spring is essential for the survival of the coenosis, which would be destroyed by early tilling, because it is formed mainly by spring flowering plants. The light ploughing at the beginning of June determines the closure of the seasonal cycle of the association. During summer harrowing is carried out to keep under control the summer species of *Stellarietea* (especially *Setaria viridis*, *Erigeron annuus*, *Amaranthus retroflexus* and *Mercurialis annua*).

This association develops on «terre rosse», silts, clays, and gravels; these soils are not heavily modified by viticulture, since it needs only light manuring.

The altitude ranges from sea level to 350-400 m (Collio hills and Karst plateau).

Synchorology. The presence of *Geranio-Allietum* has been reported in Germany, Austria, North-Eastern Italy and Slovenia.

Ass.: ***Echinochloo-Setarietum pumilae*** Felföldy 1942 corr. Mucina 1993 geogr. var. with *Calystegia sepium*, geogr. var. nova hoc loco (Tab. 6).

Syntax. syn.: *Panico-Polygonetum persicariae* Pignatti 1953, *Hibisco-Digitarietum sanguinalis* Poldini 1980, *Hibisco-Sorghetum halepensis* Poldini 1989 non Horvatic et Hodak 1960; *Oxalido-Chenopodietum* Sissingh 1950

"The vegetation of weeded summer cultures of the plain and of the hill belts"

Charact. and diff. (D) species: *Amaranthus retroflexus* (D), *Solanum nigrum* (D), *Portulaca oleracea* and *Calystegia sepium*.

Floristic composition. This association is dominated by *Setaria pumila, Digitaria sanguinalis, Echi-nochloa crus-galli, Amaranthus retroflexus, Polygonum persicaria, Euphorbia helioscopia, Chenopodium album, C. polyspermum, Convolvulus arvensis* and *Sonchus oleraceus*. *Portulaca oleracea, Solanum nigrum, Capsella bursa-pastoris* and *Taraxacum officinale* are often present, but with low cover values.

Syntaxonomy. In the attempt to attribute the relevés of Friuli-Venezia Giulia, we first considered two associations already described for weeded crops: *Panico-Polygonetum* Pign. 1953 (Pignatti 1952), surveyed in the eastern Venetian plain, and *Echinochloo-Setarietum pumilae* Felföldy 1942 corr. Mucina 1993, present in Central Europe (Mucina 1993), and we compared synthetic tables of weeded cultures of northern Italy (Gerdol & Piccoli 1979; Lorenzoni 1963; Poldini 1989) with those of Central Europe (Krippelová 1981; Regula-Bevilacqua 1979; Seljak 1989; Oberdorfer 1993) by means of numerical analysis. The classification (Fig. 3) shows that the relevés from Ferrara separate at a high level (0.63 of dissimilarity), while the cluster of relevés from the Venetian plain join the group of associations of Central Europe at a lower level of similarity (0.54). Hence all the examined relevés have been gathered into a single coenosis. Due to nomenclatural priority, the correct name is *Echinochloo-Setarietum*, whereas the binomial *Panico-Polygonetum* and *Oxalido-Chenopodietum* are syntaxonomic synonyms.

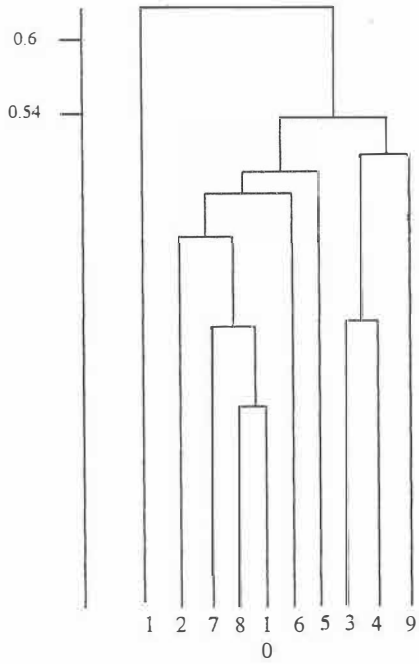

Fig. 3 – Dendrogram of weeded crops of Europe, obtained by classification of synthetic tables (similarity ratio, mean linkage). 1 = *Panico-Polygonetum* (Italy, Ferrara, Gerdol & Piccoli 1979); 2 = *Setario-Galinsogetum* (Croatia, Regula-Bevilacqua 1979); 3 = *Setario-Galinsogetum* (Slovakia, Krippelová 1981); 4 = *Oxalido-Chenopodietum* (Slovakia, Krippelová 1981); 5 = *Panico-Polygonetum* (Italy, Eastern Venetian plain, Lorenzoni 1963); 6 = *Oxalido-Chenopodietum* (Italy, Eastern Venetian Plain, Lorenzoni 1963); 7 = *Setario-Galinsogetum* (Slovenia, Seljak 1989); 8 = *Oxalido-Chenopodietum* (Slovenia, Seljak 1989); 9 = *Setario-Galinsogetum* (Germany, Oberdorfer 1993); 10 = relevés from Friuli – Venezia Giulia.

Although the eastern Venetian plain and Central Europe belong to different biogeographical regions with different «head associations» (see Syntaxonomy of *Geranio-Allietum*), it is also true that coenoses of weeded cultures are subject to a levelling anthropogenic pressure.

The attribution of this association to the *Panico-Setarion* alliance is due to the high participation of species of the tribe *Panicoideae* (*Setaria pumila*, *Digitaria sanguinalis* and *Echinochloa crus-galli*), of *Galinsoga parviflora* and *Chenopodium polyspermum*. The framing in *Chenopodietalia* is justified by the presence of *Sonchus oleraceus*, *S. asper*, *Lamium purpureum* and *Euphorbia helioscopia*. *Chenopodium album*, *Capsella bursa-pastoris*, *Erigeron annuus*, *Stellaria media*, *Fallopia convolvulus*, *Veronica persica* and *Setaria viridis* show adherence to the *Stellarietea* class.

Variability. Because of its very large geographical distribution, *Echinochloo-Setarietum* exhibits a certain variability. In Friuli-Venezia Giulia a Southeastern-Alpine race is present, which is characterized by some thermophilous species such as *Calystegia sepium*, *Euphorbia helioscopia*, *Polygonum persicaria* and *Chenopodium polyspermum*. This SE-Alpine race is not homogenous; on the basis of biogeographical considerations, it is possible to segregate two sub-races (Fig. 4):

a) Karstic sub-race (Tab. 6, rels. 46-63), distinguished by: *Veronica persica*, *Agropyron repens*, *Cirsium arvense*, *Amaranthus graecizans*, *Diplotaxis muralis*, *Erodium cicutarium*, *Trifolium incarnatum/molinieri* and *Stachys palustris*;

b) Friuli sub-race (Tab. 6, rels. 1-23), distinguished by the absence, or the negligible presence, of Karstic differential species.

Within the two sub-races, parallel ecological responses to changes in temperature and in soil moisture can be observed. We can therefore identify a cool variant and a warm one of each subrace. The cool variants are differentiated by *Galinsoga parviflora*, *Stellaria media*, *Fallopia convolvulus*, *Lamium purpureum* and *Trifolium pratense*, while the warm ones by *Sorghum halepense* and *Hibiscus trionum*. In the Karst the cool variant is found at the bottom of dolines, while the warm one is found in the south-exposed terraced cultures; the warm variant has already been described as a race of *Hibisco-Sorghetum halepensis* Horvatic et Hodak 1960 by Poldini (1989), who framed it in the Mediterranean alliance *Diplotaxidion* Br.-Bl. 1936. According to the new results, this alliance is excluded from Friuli-Venezia Giulia. In Friuli, the cool variant is found at the bottom of pre-Alpine valleys and on the Friulian hills, while the warm one is found in the plain.

Subassociation. One new subassociation has been detected:

xanthietosum italici subass. nova, holotypus Tab. 6 rel. 24 (Tab. 6, rels. 24-28). This subassociation has been recorded in the crop fields of reclaimed areas of Friuli, where the soil texture limits the water flow, increasing the soil moisture. It is differentiated by *Polygonum lapathifolium* (which completely replaces *P. persicaria*), *Bidens tripartita*, *B. frondosa*, *Xanthium italicum* and *Lycopus europaeus*. These

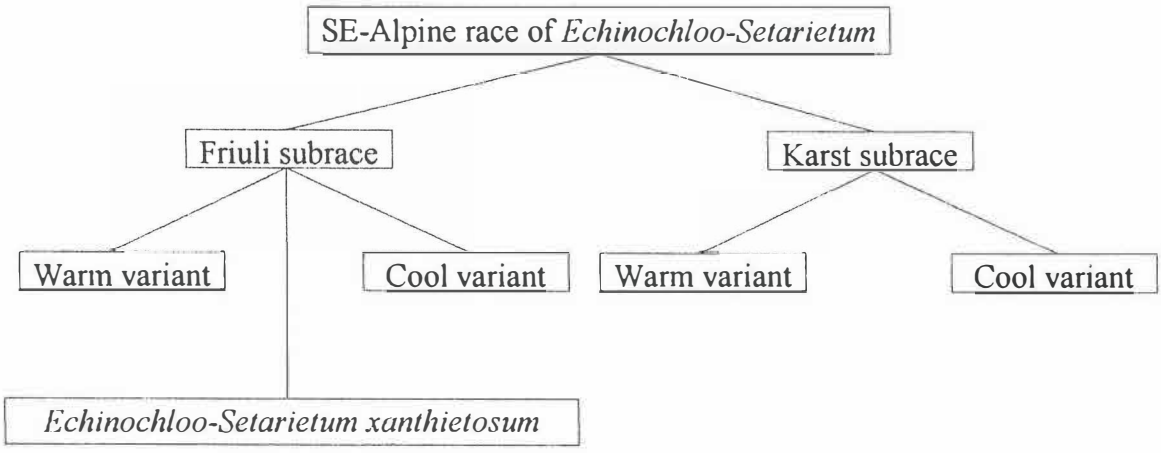

Fig. 4 – Variability of *Echinochloo-Setarietum*.

Tab. 6 – *Echinochloo-Setarietum pumilae* Felfoldy 1942 corr. Mucina 1993 geogr. var. with *Calystegia sepium* var. nova hoc loco.

	Releves n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
	Altitude (x10m)	40	37	35	40	30	30	39	43	35	2	5	6	34	34	28	26	3	1	1	1	1	11	2	1	1	1	30	30
	Total n. of species (spor. incl.)	18	21	23	18	20	18	19	15	22	9	13	27	13	19	14	21	19	11	19	10	17	19	16	19	21	16	22	17
															Friuli sub-race												*xanthietosum*				
	Char. & diff. (DAss) sp. of ass.							cool variant												warm variant									
DAss	Amaranthus retroflexus		1	+	1	+	1	2	1	1	1	1	1		2	2	2	2	2	1	1	1	1	1	1	+	+	+	+
DAss	Calystegia sepium	2	2	+	2	1	+	+		1	+	+	+	+	1		+	2	+		1		+		1	+	1	1	1
DAss	Solanum nigrum				+		+		r	+		+						+		1	1	1	+	+	1	1	1		
	Portulaca oleracea										3	1	+					+	1	1		+	r						
	Char. & diff. (DAll) sp. alleance																												
DAll	Digitaria sanguinalis	+	+		2	1	3		+		r	1	1		1	1	+	2	1	1		1	1	1		+	+		
DAll	Setaria pumila	2	2	1	2	1	+	2	2	2	+	1	1	1	1	1	2	1					1	+	1	+	1	1	1
DAll	Echinochloa crus-galli	+	1			+	+	2	2	4	+	+	2	2	+	1	1	2	2	2	1	2	1	1	1	1	+	2	2
DAll	Panicum miliaceum																												
	Diff. sp. SE-alpine race																												
K	Polygonum persicaria	+	1	+	+	1	1	2	1	1		1	1	+			+	r	1	2	2	2	2	1					
DO	Euphorbia helioscopia	1	1	+	1	+		1	+	r				+	+	+	+			+		r	+		+		+		+
DAll	Chenopodium polyspermum	2	2	1	+	+	1	2	2	+	+							+							+				1
	Diff. sp. Karst subrace																												
K	Veronica persica	+	1	+	+					+			+				+	+		+					r				
	Agropyron repens															+	+			r							+		+
K	Cirsium arvense				1									r								+	+						
K	Setaria viridis																												
	Amaranthus graecizans																	+											
O	Diplotaxis muralis		+																										
O	Erodium cicutarium																												
	Trifolium incarnatum\ molinieri																												
	Stachys palustris																												
	Diff. sp. warm variant																												
	Sorghum halepense																1			+	+	+	+					+	+
	Hibiscus trionum																	+							+	+			
	Diff. sp. cool variant																												
DAll	Galinsoga parviflora	3	3	4	2	2	4	3	3	3	4	2	2	1	3	1	1	+		+									
K	Stellaria media	2		1	2	1	2	2	3	1							1												
K	Fallopia convolvulus	+	1	2			+	1	+									r											
DO	Lamium purpureum	+	2	+	1	+	1						r																
	Trifolium pratense			+				+		+			r																
	Diff. sp. subass. (*xanthietosum*)																												
K	Polygonum lapathifolium																		r	+			r		1	1	+	1	2
	Bidens tripartita																							1	1	2	2	2	2
K	Xanthium italicum																							1	+	+	+	1	
	Bidens frondosa		+																							+		+	1
	Lycopus europaeus																								+	+			
	Char. & diff. (DO) sp. Chenopodietalia																												
DO	Sonchus oleraceus	2	2	1	+		r	1	2	1					+		+	+		+		r					+	+	+
DO	Sonchus asper					r				+							r		r						+	+			r
	Sonchus arvensis														r														
	Galinsoga ciliata	2															r												
	Euphorbia peplus												r																
	Lamium amplexicaule																												
	Class species																												
	Chenopodium album	1	2	2	2	1	1	3	2	1	1	1	1	+	2	1	1	3	2	1	1	1	+	+	+	1	1	+	1
	Capsella bursa-pastoris	1	1	+			+	+	1	+		+	+	+	+	+	1			+									
	Erigeron annuus			+		+									+	+	+	+				+	+	+	r	+		+	
	Senecio vulgaris																	r		r									r
	Mercurialis annua											+																	
	Sinapis arvensis																												
	Datura stramonium																									+	+		
	Conyza canadensis														+													+	
	Vicia sativa (aggr.)																											+	
	Anagallis arvensis												+											r					
	Geranium molle																												
	Oxalis fontana												+															+	
	Geranium pusillum																												
	Cardamine hirsuta					r																							
	Oxalis corniculata		+					+																					
	Viola tricolor			r																									
	Brassica napus																												
	Acalypha virginica												1											+					
	Companions																												
	Taraxacum officinale	+	+	+		+	+	1		+			+	+		+		+			+		r	r	+		+	+	
	Convolvulus arvensis			1		+			1	+									+										
	Polygonum aviculare						1			+			r		+								+		+	+		1	
	Ranunculus repens			+	1	+		1					+	+														1	
	Equisetum arvense				r												+			+	1	+		r		1		1	1
	Cynodon dactylon													r															

Tab. 6 - Continued.

29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63			
3	2	34	25	20	21	15	2	30	2	14	28	26	27	1	25	24	25	15	20	23	29	31	37	42	43	33	28	32	40	49	45	42	48	49			
27	11	12	24	19	16	15	17	20	18	6	13	14	19	10	11	12	25	24	15	15	22	27	31	19	16	20	31	26	24	23	32	22	19	23			
Sorghum halepense **agroform**																	**Karst sub-race**																				
																	warm variant						**cool variant**														
1	+	+	1	1		1		2	1	+	1	1	1	3	+	+	1	1	1	1		+	+	2	1	1	1	+	2	2	1	3	3	2	58	100	V
+	+	1	+		+	+	1	2	1	2	+	+	1		+	+	3	2									+		2	+	1		2		45	78	IV
+			r		+	+	+	+	+	+		r	r	+	1	1	1	+	+		+	2	+	1		+	r		+		+	2		+	40	69	IV
								+											+	2												+			12	21	II
		+		+	1	2	1	+		+	+	1	+	1	1	1	2	1	1	2	+	3	2			+					+	+			43	74	IV
1	2				1	+	2	+	1		+					1	1	+	3		1	2	1	1		+		1		1	1				44	76	IV
			+		r		+						r				1				2		1	1			1	r			+				37	64	IV
																						1				1									2	3	I
r	+	r	1	1	+	+	+		+		+	+	+	+	r	+		r			1			+	2	2	1	2	1	1	1		+	+	47	81	V
+		r	r	+	+	+	+	+	+							r	1	+			+		+	+	+	+	+	1	+	1	+	1			41	71	IV
												+																1	1	2	2	+	+		20	34	II
				r			+				+		+				1	1	+	+	+		1	2			2	1	1	2	1			1	27	47	III
+		+													+	+	1	2	1		+		3	3	3	1	1	2	2	2	2				22	38	II
		+									+						1		+		2	2	+						1	+	1	+	1	1	17	29	II
2						+	+											1	1	2		1	3	2	1	1						2			12	21	II
																	2	+	1	1			1	1	2						+	1	+		11	19	I
																	1	+	+	1	1		+				2	2	1		+				11	19	I
																	+				r		+											+	4	7	I
																		+									r				+	+			4	7	I
																													2	1	+				3	5	I
2	2		r	1	+				r	1		r	1	+				1					+												19	33	II
2																	1	1	1	+	1	4	+									+			12	21	II
			+	r	+	r			1		1	1	1	+	1	+											2	1		+	+		r		34	59	III
			r									+	+				1			+					1		1	2		1	2	1	+	1	22	38	II
+																					+	+	+		1	1	+	+	+		1	1	+	+	20	34	II
			+	+																							+	+		+	+				13	22	II
																					r	+			+		1	+			+			+	11	19	I
																																			8	14	I
						1																													7	12	I
																																			5	9	I
																																			4	7	I
																																			2	3	I
			r					+	r				+				+			+	+	+	+	1			+	+		2	1		+		31	53	III
				r									r														+	+	1		+	1		1	15	26	II
																							1				2		1	1		1	1		7	12	I
								+																											3	5	I
																																			1	2	I
																																+			1	2	I
+			+	1	1	1		2	1		+	1	1	+		1	1	2	1	1	3	+	+	2		1	2	2	2	2	2	1	2	2	57	98	V
			+					+			+	+	+	r	r	+	+						+	+			1	1	+	1	1	+	1	1	33	57	III
r			r					+				+	+																						17	29	II
r				r	+			r	r								r			+				+			+			+	+			+	15	26	II
	+	+	1	1	+	+	+				+												2	2	1	1								1	14	24	II
	+																	+				1	r		1				+	2					7	12	1
1					+	r	+																			+									7	12	I
													r									+				r									5	9	I
+																		r														+		+	5	9	I
																											1				+				4	7	I
+																				+			+											+	4	7	I
			+				+																												4	7	I
																					r						r					+			3	5	I
				r																															2	3	I
																																			2	3	I
																													r						2	3	I
+																														+					2	3	I
																																			2	3	I
				+				1	+				r				+	r		r		+	+				+	2	+	+	+	+	+		33	57	III
1	+	r	r	+			+						r	+	+		1	1	+	2	1	1	2	1	3		1		2	2	1	2	2	+	30	52	III
			+			+		+				r													2	+	1	2	+		+			+	19	33	II
		1									+		r		r	r						+							1		+				15	26	II
							1		+						+												+			2					14	24	II
4	+	1	+	+	+																+														8	14	I

species, except *Polygonum lapathifolium* (typical of cultures), come from neighbouring humid, nitrophilous habitats. This subassociation is similar to the *Polygono-Xanthietum italici* Pirola & Rossetti 1974 which has been described from the eutrophic, disturbed gravel-bed of the Reno river, near Bologna (Pirola & Rossetti 1974), and to *Polygono-Bidentetum* (W. Koch 1926) Lohm. 1950, a ruderal association of *Bidentetea tripartiti* Tx., Lohm. et Prsg. 1950 (Regula-Bevilacqua 1979).

Agroform. One agroform has been defined:

— *Sorghum halepense* agroform (Tab. 6, rels. 29-45): it is typical of intensive cultivation with use of heavy ploughing and high input of herbicides and of mineral manure. The relevés are characterized by very low cover and strong quantitative modification of the interspecific relationships (Ferrari *et al.* 1979). The permanence of association differential species assures the link with the typical coenosis.

Life forms and chorotypes. Therophytes prevail, and, in the Friuli subrace, they reach the highest value among the studied coenoses (73.1%). Geophytes are scarce; only in the *Sorghum halepense* agroform (15.1%) and in the Karst subrace (14.8%) their value is significant, due to the presence of *Sorghum halepense* (Friuli) and of *Agropyron repens* (Karst).

The most frequent chorotypes are Cosmopolitan, adventitious and palaeotemperate.

Synecology. *Echinochloo-Setarietum* is present in weeded summer cultivation, such as maize, soy-bean, and, to a lesser degree, potatoes. After sowing, these cultures undergo weeding and hoeing, but nowadays weeds are mainly controlled by the use of herbicides.

Nowadays the maize cultures can produce a biomass of 450-500 q ha^{-1} in 100-200 days. Maize exploits at best the modern techniques of manuring, irrigation, etc., but it is very sensitive to weed competition. This is due to its inability to recover from damages caused by the development of weeds, because of its short growth season. Moreover, it is the only cereal sowed in rows, and for this reason it is not able to express the typical spatial competitivity of *Gramineae*. In Friuli-Venezia Giulia, this susceptibility is enhanced by low spring temperatures, which delay the early growth stages. Nevertheless, maize cultivation has become an easy task, thanks to the use of triazinic herbicides (Cassani 1986). Their intensive and extensive use have selected some resistant weeds. As we can observe from the phytosociological relevés, in this particular ecosystem some species are now very frequent and widespread, as they have become resistant (*Amaranthus retroflexus*, *Chenopodium album* and *Solanum nigrum*) or tolerant (monocots such as *Echinochloa crus-galli*, *Digitaria sanguinalis* and *Sorghum halepense*) to triazinic compounds (Pollastro 1989). Infestation by these species is very dangerous to maize, because most of them belong to the same family (*Gramineae*) and are therefore very competitive. Moreover, except *Chenopodium album* and *Solanum nigrum*, they are C4 plants (as maize). Under favourable environmental conditions, C4 species are known to be very competitive against C3 species (Baker 1972, Collins & Jones 1985). Moreover, since triazinic substances operate on photosynthesis, C4 weeds take further advantage of their alternative CO_2 assimilation pathway, and can survive to these herbicides (Gutierrez *et al.* 1974).

Indeed, an overgrowth of weeds soon after sowing would seriously hamper the development of any crop. From an agronomic point of view, the damage is greater when the weed coenosis develops at the same time as the crop plant. Conversely, the growth of weeds at the end of July, when maize and soy-bean dominate, is usually tolerated and the crop coenosis consequently reaches its maximum development only in late summer (second half of August). It is then destroyed by the harvest in late August-early September (potatoes) or at the end of October-beginning of November (maize and soy-bean). This tilling calendar allows most of the weeds to fructify, thus increasing the soil seed-bank responsible for the spring renovation of the coenosis. Fragmented roots and underground organs, and weed-seeds contained in stable manure (artisan fields) also contribute considerably to such process.

The species which dominate *Echinochloo-Setarietum* (*Amaranthus retroflexus, Digitaria sanguinalis, Echinochloa crus-galli, Setaria pumila, S. viridis, Sorghum halepense*) are almost all C4, and thus need high temperature for their peculiar metabolism.

The association mainly occurs on basic soils, from gravels to silt and clay but also on the «terre rosse» of the Karst plateau.

The altitude ranges from sea level to 350-400 m. In Friuli the warm form reaches 100-150 meters, being replaced by the cool form at higher altitudes.

Synchorology. This association occurs in Central Europe but it is also present south of the Alps and in the Italian and Slovenian Karst; the southern limit of

Tab. 7 – *Galeopsido tetrahit – Galinsogetum parviflorae* ass. nova hoc loco

	Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Pr	Fr	Cl.
	Altitude (x 10 m)	40	42	55	60	73	95	92	71	59	69	47	60	61	60	71	69	82	56	117	36	74	76	64			
	Number of species (spor. incl.)	20	20	20	26	19	21	19	17	19	16	18	19	21	24	19	22	20	19	27	26	25	16	28			
	Diff. sp. of ass.																										
	Galium aparine				+	1	1	+	2	+	1	1	2	1	+	+	3	2	1			+			16	70	IV
	Galeopsis tetrahit		+	1	+	+	1	+		1					1	2	3	3	3	1		1	+		15	65	IV
	Galeopsis speciosa		1	1			+	1		1	2	1	1	1					+	1					11	48	III
K	Mentha arvensis			1			3	1	1					1				1		+		+		+	9	39	II
K	Stachys palustris	+		+						2	+	2	+	1					+			1			9	39	II
	Aethusa cynapium		1	+	r						+								r	+		1			7	30	II
	Galinsoga ciliata																	2	2		3	4	4	3	6	26	II
	Char. & diff. (DAll) sp. of all. (*Panico-Setarion*)																										
DAll	Galinsoga parviflora	3	3	2	2	4	3	2	1	4	3	3	3	5	2	2	2	1							17	74	IV
DAll	Setaria pumila	1	1	1	2	+						+	1		1				+		1			+	11	48	III
	Chenopodium polyspermum			+						+					+	+	+				+	+			7	30	II
DAll	Echinochloa crus-galli				+																2			+	3	13	I
DAll	Digitaria sanguinalis	+																			1				2	9	I
DAll	Panicum miliaceum	+																							1	4	I
	Char. & diff. (DO) sp. of order (*Chenopodietalia*)																										
DO	Sonchus oleraceus	+		1	1	r	1	1	2	2	+		1	+	1	+		+	1		1	+			17	74	IV
DO	Euphorbia helioscopia	+	r		2	+		+	r	1			r		1		+	+		+	1		+	+	15	65	IV
DO	Lamium purpureum				1	1	+	1	1			r	r		+	r	+			1		+		+	13	57	III
	Sonchus arvensis				+		1							+											3	13	I
	Class species (*Stellarietea*)																										
	Chenopodium album	2	3	3	1	2	1	+	3	2	2	1	1	1	1	1	1	2	2	1	1	1	1	+	23	100	V
	Polygonum persicaria	1	2	1	1	2	1		1	1	2	2	4	2	1	1	1	1	+	1	+	+	1	1	22	96	V
	Stellaria media	2	2	2	1	3	3	3	2	3	2	2	2		2	2	3	2	2	3	2	+	1	+	22	96	V
	Fallopia convolvulus	1	1	1	2	3	1	+	2	1	1	1	2	+	2	2	2	1	2			+			19	83	V
	Capsella bursa-pastoris	1	+	+	+		1	+		+	+	r		+	1	+	+	+		+	1		+		17	74	IV
	Cirsium arvense							+				1	1	+	1	1		1	1		1	+			10	43	III
	Veronica persica		r		+	1									+					+	1				6	26	II
	Setaria viridis				1	+				+				1					+			+			6	26	II
	Myosotis arvensis						+	1						+				+		+		+			6	26	II
	Erigeron annuus													+							+		+	+	4	17	I
	Geranium columbinum				+	+																+			3	13	I
	Matricaria chamomilla				r											r									2	9	I
	Brassica napus																r			1					2	9	I
	Sinapis arvensis																			+	+				2	9	I
	Geranium pusillum	+																							1	4	I
	Oxalis fontana	1																							1	4	I
	Oxalis corniculata			+																					1	4	I
	Sherardia arvensis								r																1	4	I
	Geranium molle														+										1	4	I
	Cardamine hirsuta																r								1	4	I
	Veronica hederifolia																			+					1	4	I
	Vicia sativa (aggr.)																					+			1	4	I
	Mercurialis annua																						+		1	4	I
	Companions																										
	Convolvulus arvensis	+		1	2	2	+	2	1	1		1	1		1	1	+	1			2	1	+		17	74	IV
	Calystegia sepium		1	1			1		2	1		1	1	1	2	2	1	1	1		2			+	15	65	IV
	Bidens tripartita	r	1	+							r				1		2	+	1		+				9	39	II
	Taraxacum officinale (aggr.)				+		+			+					+		+				+				6	26	II
	Equisetum arvense	2				+		+							+						2				5	22	II
	Ranunculus repens		1														1		+		1			+	5	22	II

its distribution is yet unknown.

Ass.: ***Galeopsido tetrahit-Galinsogetum parviflorae*** ass. nova hoc loco (Tab. 7).
"The vegetation of weeded summer cultivation of the mountains"

Holotypus: Tab. 7 rel. 10.
Diff. species: *Galium aparine, Galeopsis tetrahit, G. speciosa, Mentha arvensis, Stachys palustris, Galinsoga ciliata* and *Aethusa cynapium.*
Floristic composition. The coenosis is dominated by *Galinsoga parviflora*, although it is sometimes entirely replaced by the congeneric *G. ciliata. Sonchus oleraceus, Chenopodium album, Polygonum persicaria, Stellaria media* and *Fallopia convolvulus* are very frequent and show high cover values. There are also interesting penetrations of *Galeopsis speciosa* and *G. tetrahit* from the edge of the surrounding woods.
Syntaxonomy. The syntaxonomical framing of the relevés has been rather problematic. Although the floristic link with *Echinochloo-Setarietum* is evident, most of the *Panicoideae* species (differentials of that association) are missing. Due to their C4 metabolism, they are not able to grow (or are not competitive) in mountain climate. Friuli relevés have been compared with *Galinsogeto-Portulacetum* Br.-Bl. 1949 (Braun-Blanquet 1949; Pedrotti 1959a, 1959b), described for the Central Alps, where the cultivation of autumn-winter cereals is possible thanks to the continental climate, with spring and summer less rainy and warmer than in Carnia. The floristic compositions of the two coenoses are significantly different, and they cannot be referred to the same association. The floristic differences are due to the coexistence of *Centaureetalia* and *Chenopodetalia* species in the Central Alps association. Therefore we prefer to consider the Carnic relevés as a new, independent association with the name of *Galeopsido tetrahit-Galinsogetum parviflorae*.

This association has to be referred to the *Panico-Setarion* alliance for the presence of *Galinsoga parviflora*, *Setaria pumila* and *Chenopodium album.* Among *Chenopodietalia* species *Sonchus oleraceus*, *Euphorbia helioscopia* and *Lamium purpureum* are the most frequent; among the *Stellarietea* ones *Chenopodium album*, *Polygonum persicaria*, *Stellaria media*, *Capsella bursa-pastoris* and *Fallopia convolvulus*.
Life forms and chorotypes. Therophytes are dominant (71.4%), followed by hemicryptophytes (20.6%) and geophytes (8.1%).

Because of the particular climatic conditions in which this coenosis occurs, large distribution chorotypes dominate; among these, Cosmopolitan (32.6%), eurasiatic (20.7%) and circumboreal (12.5%) are the best represented. For the same reason, the frequency values of eurymediterranean (1.9%) and steno-mediterranean species (0.3%) are very low, whereas those of adventitious (14.2%) and palaeotemperate (12.6%) are similar to the other coenoses studied in this paper.
Synecology. The association has been found in small fields near villages in cool mountain valleys, especially in Carnia. These fields are mainly cultivated with potatoes and beans (sometimes in the same plot of land) and, due to the excessive altitude, maize is only seldom present. This is a rare example of artisan agriculture, where the few tilling works consist in a single hoeing operation before sowing and in a light weeding during the growth period. In the potato fields, harvest is at the end of September, while bean fields do not undergo further tilling. The soil is left to rest till the next sowing. These fields hardly exceed 300 m^2.

Galeopsido-Galinsogetum occurs in peculiar ecological conditions, in areas with high rainfalls (1600-2500 mm per year), from 400 to 1100 m on sea level, on rendzinas and brown soils, with a high input of organic matter (manuring).
Synchorology. So far, this association has been recorded only in weeded fields of the mountains of Friuli.

Ass.: ***Papaveretum apuli*** ass. nova hoc loco (Tab. 8)
"The vegetation of autumn-winter cereals of the plains of Veneto and Friuli"

Holotypus: Tab. 8, rel. 3.
Charact. and diff. species (D): *Papaver apulum, Oxalis fontana* (D).
Floristic composition. The coenosis is dominated by *Centaureetalia* (*Papaver rhoeas, Fumaria officinalis, Centaurea cyanus, Alopecurus myosuroides* and *Anthemis arvensis*) and by *Caucalidion* (*Ranunculus arvensis, Legousia speculum-veneris, Avena fatua* and *Consolida regalis*) species. *Chenopodium album, Polygonum persicaria, Calystegia sepium* and *Poa sylvicola* are almost always present.
Syntaxonomy. The framing of this association was problematic. Pignatti (1952) found in the Venetian plain an association which was identified as *Alchemillo arvensis-Matricarietum* R. Tx. 1937. The

same author, following Tuxen's scheme (Tuxen 1950) for Central Europe, placed it in the alliance *Scleranthion annui* (Kreuseman et Vlieger 1939) Sissingh in Westhoff *et al.* 1946 (which includes acid soil coenoses), although he noted the absence of alliance species, replaced by differential species of *Caucalidion* (which includes basiphilous associations). In this respect Pignatti admitted the existence of one or more basiphilous associations of *Caucalidion*, but did not formally distinguish them (Ferro 1990). In this paper a new association is therefore described with the name of *Papaveretum apuli*.

Ranunculus arvensis, Avena fatua, Legousia speculum-veneris and *Consolida regalis* show the adherence to *Caucalidion, Papaver rhoeas, Fumaria officinalis, Centaurea cyanus, Alopecurus myosuroides* and *Veronica arvensis* to *Centaureetalia*, while the presence of *Chenopodium album, Polygonum persicaria, Lactuca serriola* and *Anagallis arvensis* supports the framing in *Stellarietea*.

Life forms and chorotypes. Therophytes are the most frequent life form (67.3%), but the percentage of hemicryptophytes is also high (25.5%).

Among the studied coenoses, *Papaveretum apuli* shows the highest value of stenomediterranean (6.5%) and eurymediterranean (22.9%) species. The remarkable percentage of neophytes (12.2%) underscores the level of anthropogenic disturbance of this association.

Synecology. This coenosis develops in cultures of autumn-winter cereals and is therefore characterized by the presence of spring therophytes. These species must fructify before the harvest in June.

The soil texture is heterogeneous: it varies from gravel to silt and clay; the soils mainly derive from calcareous substrata. This coenosis occurs below 100-150 m on sea level.

Synchorology. So far, this association has been detected only in Friuli-Venezia Giulia, but it is probably present in the whole of the Venetian plain.

Conclusions

The continuous adjustment of the segetal flora to the changing cultural techniques causes high instability in the floristic composition of the coenoses. Therefore, in the characterization of these plant communities, we privileged some ecological-structural characters (life form / growth form, and species with C4 metabolism) which remain constant.

The crop field and vineyard vegetation of Friuli-Venezia Giulia can be ascribed to four associations. This situation, due to the great changes in cultivation techniques, does not coincide with that described about 40 years ago by Pignatti (1952) and Lorenzoni (1963). Among the associations described at that time, *Panico-Polygonetum* is still valid as a well defined geographical race of *Echinochloo-Setarietum*. In Friuli-Venezia Giulia the variability of this coenosis is very high, and it is possible to identify two geographical sub-races (Karst and Friuli), two ecological-altitudinal forms, one subassociation on drained soils (*xanthietosum italici*) and one agroform in fields with a strong use of herbicides (with *Sorghum halepense*). In the same way *Cerastio-Geranietum dissecti*, described by Poldini (1980), is considered here as a geographical race of *Geranio-Allietum*, containing three different agroforms (with *Taraxacum officinale*, with *Agrostis stolonifera* and with *Arrhenatherum elatius*) induced by different cultivation techniques. Other two coenoses of autumn-winter cereals fields and of small weeded fields of the mountain belt are here described for the first time. They are, respectively, *Papaveretum apuli* and *Galeopsido tetrahit-Galinsogetum parviflorae*.

Appendix

Tab. 4 - Geranio rotundifolii-Allietum vineale

Localities: 1: Spessa di Cividale 9946/1 (UD); 2: Villanova di Farra 0047/3 (GO); 3: Sgonico 0248/3 (TS); 4: Samatorza 0248/1 (TS); 5: Pliskovica 0349/1 (SLO); 6: Bonetti 0147/3 (GO); 7: Sales 0248/3 (TS); 8: Dutovlje 0248/2 (SLO); 9: Godnje 0349/1 (SLO); 10: ibidem; 11: ibidem; 12: ibidem; 13: Tomaj 0348/3 (SLO); 14: Kreplje 0348/3 (SLO); 15: near Rocca Bernarda 9946/1 (UD); 16: Moimacco (near Villa Puppi) 9946/1(UD); 17: Felettis (Palmanova) 0045/1 (UD); 18: Virco 0144/1 (UD); 19: Moraro 0047/3 (GO); 20: between Mossa and Capriva 0047/3 (GO); 21: Corona (Mariano del Friuli) 0046/2 (GO); 22: Villanova di Farra 0047/3 (GO); 23: Moraro 0047/3 (GO); 24: Capriva del Friuli 0047/1 (GO); 25: Villanova di Farra 0047/3 (GO); 26: ibidem; 27: Moraro 0047/3 (GO); 28: Capriva del Friuli 0047/1 (GO); 29: Savogna d'Isonzo 0147/1 (GO); 30: between Lucinico and Giasbana 0047/2 (GO); 31: between Villanova and S. Lorenzo 0047/2 (GO); 32: Lucinico 0047/3 (GO); 33: Corno di Rosazzo 0046/2 (UD); 34: Gagliano di Cividale 9946/2 (UD); 35: Cividale 9946/2 (UD); 37: Campeglio (Faedis) 9846/2 (UD); 38: Orzano (Remanzacco) 9946/3 (UD); 39: Varmo 0143/2 (UD); 40: Vendoglio 9845/1 (UD); 41: Buttrio 9744/3 (UD); 42: Sterpo 0044/3 (UD); 43: between Ariis and Torsa 0144/2 (UD); 44: Faedis 9846/1 (UD); 45: Tauriano 9843/3 (PN); 46: ibidem; 47: ibidem; 48: ibidem; 49: ibidem; 50: ibidem; 51: ibidem; 52: Capriva del Friuli 0047/1 (GO); 53: Torsa 0144/2 (UD); 54: Iutizzo (Codroipo) 0043/4 (UD); 55: S. Pietro di Varmo 0043/4 (UD); 56: Sevegliano 0045/3 (UD);57: Muzzana del Turgnano

Tab.8 - *Papaveretum apuli* ass. nova hoc loco

	Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17			
	Altitude (x 10 m)	6	6	4	23	9	11	2	25	10	10	8	11	2	1	1	9	24			
	Number of species (spor. incl.)	31	30	37	37	36	41	35	32	31	39	40	29	19	30	36	37	46	Pr.	Fr.	Cl.
	Char. & diff. (DAss) sp. ass.																				
	Papaver apulum	+	+	1	+	+			1	+	2	1	+			+	2	2	13	76	IV
K, DAss	Oxalis fontana		+	+	1	+							+			+	+		7	41	III
	Char. & diff. (DAll) sp. all. (*Caucalidion*)																				
	Ranunculus arvensis	+	+	1	+	1	2	+	2	+	+	1	+		+		+	2	15	88	V
	Legousia speculum-veneris			1	+	+	+	+	2	+	3	1	+		2	+	1	1	14	82	V
	Consolida regalis	1	+	+	+	+	+		+		3	1					+	+	11	65	IV
	Avena fatua	+	+	1			1	1	+	2	+				+	+			10	59	III
DAll	Silene vulgaris		+		+	+	+				+	1	1		+				8	47	III
	Valerianella rimosa									+	+	+	+				+	+	6	35	II
DAll	Chaenorrhinum minus				+			+			+						+	+	5	29	II
DAll	Valerianella locusta			2					+			+					+		4	24	II
	Valerianella eriocarpa	+														+			2	12	I
	Fumaria vaillantii			+								+							2	12	I
	Ajuga chamaepitys											1	+						2	12	I
	Char. & diff. (DO) sp. ord. (*Centaureetalia*)																				
DO	Papaver rhoeas	1	2	2	+	1	+	+	1	1	4	3	1	2	2	2	3	2	17	100	V
DO	Fumaria officinalis	+	+	1	1	1	+	1	1	+	1	+				+	+	1	14	82	V
	Centaurea cyanus	2	1	4	1	+	+	2	4	1	2		3					1	12	71	IV
DO	Alopecurus myosuroides	+	+	1				3	2	1	2	2	1		+	3			11	65	IV
DO	Anthemis arvensis	+	2	1		+		+	1	1	1	2	1						10	59	III
DO	Veronica arvensis			+	+	+					+	+	+		+		+	+	9	53	III
	Cerastium glomeratum				+	+	+				1	1	1	+			1	+	9	53	III
DO	Viola tricolor	3		+	+	+			1	+	1	1							8	47	III
DO	Myosotis arvensis	+		+			+	+	+	+	+							+	8	47	III
	Raphanus raphanistrum				1	1		+	+	2	+						+	1	8	47	III
	Buglossoides arvensis	+	1			1	2			2		+	+						7	41	III
	Arabidopsis thaliana					+		+			2	+					+	1	6	35	II
DO	Matricaria chamomilla			+				+								4	+	2	5	29	II
	Papaver argemone				+		+	+							+				4	24	II
	Lolium multiflorum						1	1	2										3	18	I
	Legousia hybrida	+	+																2	12	I
	Rapistrum rugosum													+	+				2	12	I
	Aphanes arvensis			1															1	6	I
	Class species (*Stellarietea*)																				
	Chenopodium album	+	4	+	+	1	+	+	+	+	+	+		2	+	+	2	2	16	94	V
	Polygonum persicaria		+		1	+	+	+	1	+	+	+		2	1	3	+	+	14	82	V
	Capsella bursa-pastoris	+	+	1	1	+	+	+	1				+	+		+	+	+	13	76	IV
	Anagallis arvensis	+	+	+	1		+	+	+		+			+	+	+	1	+	13	76	IV
	Veronica persica	+	+	1	1	1	+				+	1		+	+	+	1	+	13	76	IV
	Stellaria media	+		+	+	1	+	+	+	+		1		+	+	1		+	13	76	IV
	Vicia sativa		+	+	+	+	1		1	1	+	+	+		+	+			12	71	IV
	Fallopia convolvulus	2		+		1	1	+	+	+	1	1		1				1	11	65	IV
	Erigeron annuus					2	+		+		+	1	2		+		1	1	9	53	III
	Sinapis arvensis			+	+	1	+		1	2					+				7	41	III
	Lactuca serriola			+							1	+				2	2	3	6	35	II
	Senecio vulgaris	+										+				1	+	1	5	29	II
	Cirsium arvense		+	+			+			1						1			5	29	II
	Bromus sterilis					+	1	+									+		4	24	II
	Mercurialis annua	+		+														+	3	18	I
	Sonchus oleraceus	+													+	1			3	18	I
	Amaranthus retroflexus			+													+	1	3	18	I
	Euphorbia helioscopia				+							+						+	3	18	I
	Sonchus asper				+												+	+	3	18	I
	Veronica hederifolia					+		+		+									3	18	I
	Conyza canadensis					+			+						+				3	18	I

Tab.8 - Continued.

Brassica napus		+		1													2	12	I
Xanthium italicum							+		1								2	12	I
Datura stramonium								+								+	2	12	I
Lamium purpureum						+										+	2	12	I
Geranium dissectum			+														1	6	I
Geranium molle			+														1	6	I
Mentha arvensis					1												1	6	I
Muscari comosum						+											1	6	I
Euphorbia falcata											1						1	6	I
Setaria pumila												+					1	6	I
Oxalis corniculata													+				1	6	I
Amaranthus graecizans														1			1	6	I
Euphorbia peplus														+			1	6	I
Cardamine hirsuta															+		1	6	I
Digitaria sanguinalis															1		1	6	I
Galinsoga parviflora																+	1	6	I
Companions																			
Calystegia sepium	2	1		1	1	+	1	1	1	+	1	1	2	+	1	1	1	16	94	V
Poa sylvicola			+	1	2	2	2		1	2	2	1	1	2	1	1	1	14	82	V
Polygonum aviculare	1		+	1	1	+	+	1	1	1			1	1	+		+	13	76	IV
Mentha longifolia	+	+		+	1	1	1		+	+	+			+	+		+	12	71	IV
Sorghum halepense	+	1	+	+						+	1	+			1	1	2	10	59	III
Silene alba	+	+					+	+	+	+	1	1	1		1			10	59	III
Arenaria serpyllifolia		1				+	+			1	+	1		+	1	+	+	10	59	III
Lolium multiflorum	1	+		1					2	1		1			+	1	1	9	53	III
Medicago lupulina		+				+					+	+			+		+	6	35	II
Convolvulus arvensis			+			1				+				1	1		1	6	35	II
Artemisia verlotorum	1					+	+	1							+			5	29	II
Daucus carota				+	+	+					2			1				5	29	II
Agropyron repens				1	1		+						2	+				5	29	II
Ranunculus arvensis						+	+				+		+				1	5	29	II
Rorippa sylvestris						+		+				+			1		+	5	29	II
Galium aparine							+		+					+	+	+		5	29	II
Trifolium repens		+		1									+	1				4	24	II
Artemisia vulgaris				+							2	1					2	4	24	II
Conyza albida						+				+						1	1	4	24	II
Crepis taraxacifolia						+				+		2				2		4	24	II
Equisetum arvense													1	2	+	+		4	24	II

0144/4 (UD); 58: Colloredo di Montalbano 9844/2 (UD); 59: Buttrio 9744/3 (UD); 60: Nimis 9745/4 (UD); 61: S. Croce 0248/3 (TS); 62: ibidem.

Sporadic species: *Daucus carota:* + (1), + (15), + (17), + (19), r (35), + (37), + (48), + (56), + (59); *Urtica dioica:* + (28), + (37), + (43), 1 (45), 3 (50), 1 (51), 4 (54), + (56), r (60); *Trifolium incarnatum/molineri:* 1 (4), 1 (7), + (8), + (10), + (11), + (12), + (13); *Arenaria serpyllifolia:* + (13), + (17), + (20), r (24), r (26), + (31), r (35); *Cynodon dactylon:* + (13), 1 (17), r (26), + (34), 1 (43); *Raphanus landra:* + (16), + (17), + (19), + (22), 1 (34), 2 (35); *Lamium maculatum:* + (10), + (21), + (22), + (36), + (62); *Clematis vitalba:* r (15), + (16), + (49), + (50), + (62); *Artemisia vulgaris:* + (18), + (21), 1 (26), 1 (32), + (49); *Ajuga reptans:* + (38), + (55), + (58), + (59), + (60); *Crepis foetida:* + (3), + (4), + (20), + (21); *Galium aparine:* + (5), + (12), r (23), r (58); *Ranunculus acris:* + (15), r (44), + (55), + (60); *Polygonum aviculare:* + (1), + (48), + (50); *Brassica rapa:* 1 (4), + (10), + (21); *Cerastium pumilum:* + (6), 2 (14), r (61); *Galium lucidum:* + (15), 1 (37), + (38); *Medicago sativa:* r (35), + (52), + (56); *Pastinaca sativa:* + (39), 2 (51), + (60); *Glechoma hederacea:* + (44), + (54), 1 (57); *Anthoxanthum odoratum:* + (58), + (59), + (60); *Picris hieracioides:* + (39), 1 (47); *Cardaria draba:* 1 (4), + (13); *Malva sylvestris:* + (5), + (44); *Poa pratensis:* + (86), + (62); *Sisymbrium officinale:* + (10), + (34); *Rorippa sylvestris:* + (13), 1 (16); *Allium ampeloprasum:* 1 (14), r (44); *Aristolochia clematitis:* + (16), + (62); *Sambucus ebulus:* + (16), + (54); *Leucanthemum vulgare:* + (17), + (56); *Artemisia verlotorum:* 1 (19), + (61); *Ranunculus sardous:* 1 (21), + (31); *Capsella rubella:* + (29), 1 (36); *Silene vulgaris:* + (34), + (60); *Holcus lanatus:* + (37), + (58); *Verbena officinalis:* + (45), + (46); *Crepis capillaris:* + (48), + (51); *Veronica chamaedrys:* 1 (54), 1 (60); *Brachypodium sylvaticum:* + (61), + (62); *Carex pairae* 1 (61), + (62); *Rubus caesius:* r (61), + (62); *Linaria vulgaris:* + (3); *Bromus madritensis:* + (4); *Erophila verna:* + (5); *Vicia hirsuta* + (8); *Plantago media:* + (13); *Medicago minima:* + (13); *Trifolium campestre:* + (13); *Inula salicina:* + (15); *Tussilago farfara:* + (15); *Ononis spinosa:* + (16); *Solanum dulcamara:* + (16); *Leontodon hispidus:* + (17); *Sanguisorba minor:* r (18); *Arabidopsis thaliana:* + (19); *Bromus molliformis:* + (19); *Ranunculus parviflorus:* + (23); *Cirsium vulgare:* + (28); *Fragaria vesca:* + (28); *Lapsana communis:* + (34); *Senecio inaequidens:* + (34); *Tragopogon orientalis:* + (34); *Lotus corniculatus:* + (37); *Saponaria officinalis:* + (37); *Hypochoeris radicata:* + (38); *Cerastium brachypetalum:* + (40); *Carex hirta* + (42); *Euphorbia*

lathyris: r (42); *Aegopodium podagraria:* + (44); *Buphthalmum salicifolium:* + (44); *Hypochoeris glabra:* + (52); *Valeriana officinalis:* + (52); *Pimpinella major:* + (57); *Cruciata laevipes:* + (59); *Allium sphaerocephalon:* 1 (61); *Avena barbata:* 1 (61); *Medicago lupulina:* r (62); *Eupatorium cannabinum:* 1 (62).

Tab. 6 - Echinochloo-Setarietum pumilae

Localities: 1: Enemonzo 9543/3 (UD); 2: Villa Santina 9543/4 (UD); 3: Esemon di Sotto 9543/3 (UD); 4: Formeaso 9544/3 (UD); 5: Socchieve 9643/1 (UD); 6: Enemonzo 9543/3 (UD); 7: Esemon di Sopra 9543/3 (UD); 8: Esemon di Sopra 9543/3 (UD); 9: Terzo 9544/3 (UD); 10: Subida (Cormons) 0046/2 (GO); 11: Moraro 0047/3 (GO); 12: Capriva del Friuli 0047/3 (GO); 13: Terzo 9544/3 (UD); 14: Esemon di Sotto 9543/3 (UD); 15: Cavazzo 9644/1 (UD); 16: Amaro 9644/2 (UD); 17: Manzano 0046/1 (UD); 18: Gorgo (Latisana) 0244/1 (UD); 19: Gorgo (Latisana) 0244/1 (UD); 20: Gorgo (Latisana) 0244/1 (UD);21: Latisana 0144/3 (UD); 22: Perteole 9945/1 (UD); 23: Flambruzzo 0144/1 (UD); 24: Marano 0245/1 (UD); 25: Aquileia 0246/1 (UD); 26: S. Giorgio di Nogaro 0145/3 (UD); 27: Preval (Cormons) 0047/1 (GO); 28: ibidem; 29: Fagagna 9844/4 (UD); 30: Tolmezzo 9544/3 (UD); 31: Terzo 9544/3 (UD); 32: Gemona 9744/2 (UD); 33: ibidem; 34: Artegna 9744/4 (UD); 35: Flambruzzo (Rivignano) 0144/1 (UD); 36: Romans d'Isonzo 0146/2 (UD); 37: Terzo 9544/3 (UD); 38: Fagagna 9844/4 (UD); 39: Maiano 9844/1 (UD); 40: Terzo 9544/3 (UD); 41: Cavazzo 9644/1 (UD); 42: ibidem; 43: Gemona 9744/2 (UD); 44: Cavazzo 9644/1 (UD); 45: Codroipo 0043/1 (UD); 46: Pliskovica 0349/1 (SLO); 47: Ferletti 0147/3 (GO); 48: Medeazza 0247/2 (TS); 49: Sales 0248/3 (TS); 50: S. Michele 0147/1 (GO); 51: Pliskovica 0349/1 (SLO); 52: Medeazza 0247/2 (TS); 53: Dutovlje 0349/1 (SLO); 54: Lokev 0349/1 (SLO); 55: Villanova di Farra 0047/3 (GO); 56: Grozzana 0349/3 (TS); 57: ibidem; 58: Basovizza 0349/1 (TS); 59: Percedol 0248/3 (TS); 60: S. Canziano 0349/2 (SLO); 61: Rupinpiccolo 0248/4 (TS); 62: ibidem; 63: Sgonico 0248/3 (TS).

Sporadic species: *Medicago lupulina:* r (5), + (9), + (14), + (29), r (37), + (46), r (52), + (54), + (55); *Trifolium repens:* + (2), + (5), + (13), + (14), + (15), r (23), + (40), + (66); *Artemisia vulgaris:* r (15), r (18), + (21), + (22), r (32), + (33), + (37), r (55); *Diplotaxis tenuifolia:* r (6), 1 (20), + (29), + (48), + (50), + (25); *Rumex crispus:* + (12), r (15), 1 (16), + (32), + (50), r (52), + (54); *Plantago major:* r (3), + (6), + (25), + (27), + (32), + (57); *Daucus carota:* r (3), + (14), + (27), + (29), r (38), + (46); *Mentha spicata:* + (22), + (25), + (34), 1 (38), + (47), r (55); *Plantago lanceolata:* r (12), + (47), + (51), + (57), + (66); *Verbena officinalis:* + (12), r (21), r (24), r (25), + (55); *Potentilla reptans:* r (21), + (29), + (36), 1 (47), 2 (52); *Vicia sepium:* + (7), + (9), r (30), r (43); *Rumex obtusifolius:* r (29), + (34), 2 (54), 1 (58); *Silene vulgaris:* r (1), r (14), r (55); *Agrostis stolonifera:* + (7), r (15), 1 (51); *Rubus caesius:* r (22), 1 (38), 1 (39); *Lythrum salicaria:* r (21), + (28), r (36); *Aristolochia clematitis:* + (51), + (53), 1 (66); *Poa annua* + (3), + (12); *Glechoma hederacea:* r (5), 1 (12); *Rorippa sylvestris:* + (11), 1 (52); *Arenaria serpyllifolia:* + (14), r (33); *Cirsium vulgare:* r (16), r (39); *Heliotropium europaeum:* + (29), r (52); *Armoracia rusticana:* 1 (5); *Chaenarrhinum minus:* r (14); *Mentha longifolia:* + (21); *Cichorium intybus:* r (23); *Abutilon theophrasti:* + (26); *Polygonum mite:* + (27); *Picris hieracioides:* + (29); *Helianthus tuberosus:* + (30); *Aegopodium podagraria:* + (31); *Hypericum perforatum:* r (33); *Lysimachia nummularia:* r (36); *Sambucus ebulus:* + (37); *Vicia cracca:* r (37); *Brassica nigra:* r (38); *Picris echioides:* + (38); *Crepis rhoeadifolia:* + (46); *Nicandra physalodes:* + (47); *Chondrilla juncea:* r (50); *Achillea millefolium:* + (51); *Centaurea weldeniana:* r (51); *Galium mollugo:* + (51); *Leucanthemum vulgare:* r (51); *Prunella vulgaris:* + (51); *Misopates orontium:* r (52); *Stachys annua:* + (53); *Lolium multiflorum:* + (57); *Medicago sativa:* 1 (57); *Euphorbia falcata:* + (63).

Tab. 7 - Galeopsido tetrahit-Galinsogetum parviflorae

Localities: 1: Socchieve 9543/3 (UD); 2: S. Pietro di Zuglio 9544/1 (UD); 3: Cercivento 9443/3 (UD); 4: Ampezzo 9542/4 (UD); 5: Avaglio (Lauco) 9543/3 (UD); 6: Forni Avoltri 9442/2 (UD); 7: Ravascletto 9443/3 (UD); 8: between Liariis and Clavais (Ovaro) 9543/1 (UD); 9: Magnanins (Ravascletto) 9443/3 (UD); 10: Lenzone (Ovaro) 9543/1 (UD); 11: Cella (Ovaro) 9543/1 (UD); 12: Lenzone (Ovaro) 9543/1 (UD); 13: Liariis (Ovaro) 9543/1 (UD); 14: Oltris (Ampezzo) 9542/4 (UD); 15: between Trava and Avaglio (Lauco)9543/3 (UD); 16: Osais (Val Pesarina) 9442/2 (UD); 17: Pesariis 9442/4 (UD); 18: Cercivento 9443/3 (UD); 19: Sauris di sotto 9542/1 (UD); 20: Villa Santina 9543/2 (UD); 21: Paularo 9444/3 (UD); 22: Mersino sup. (M. Matajur) 9847/3 (UD); 23:Malga Vidoni (M. Chiampon) 9745/1 (UD).

Sporadic species: *Poa annua:* + (7), + (10), + (17), 1 (20); *Trifolium pratense:* + (13), + (21), + (22), + (23); *Trifolium repens:* + (4), + (13), + (22), + (23); *Daucus carota:* + (10), + (12), + (23); *Aegopodium podagraria:* + (16), + (19), + (23); *Silene alba:* r (2); + (19); *Polygonum aviculare:* + (4), + (8); *Urtica dioica:* + (4), 1 (23); *Nepeta cataria:* + (5), + (15); *Lamium album:* + (6), + (16); *Glechoma hederacea:* + (11), + (20); *Myosoton aquaticum:* 1 (11), 1 (12); *Leucanthemum vulgare:* + (19), + (22); *Phalaris canariensis:* + (1); *Artemisia vulgaris:* r (2); *Lamium maculatum:* + (2); *Rumex obtusifolius:* + (6); *Myosotis sylvatica:* r (8); *Atriplex tatarica:* r (13); *Galium lucidum:* + (14); *Geranium pyrenaicum:* + (15); *Agropyron repens:* 1 (19); *Lathyrus pratensis:* + (19); *Ranunculus acris:* + (19); *Silene vulgaris/vulgaris:* + (19); *Vicia hirsuta:* r (19); *Vicia sepium:* + (19); *Dactylis glomerata:* + (20); *Arrhenatherum elatius:* + (21); *Borago officinalis:* + (21); *Euphorbia lathyris:* + (21); *Lotus corniculatus:* + (22); *Centaurea nigrescens:* + (23); *Crepis capillaris:* + (23); *Galium mollugo:* + (23); *Holcus lanatus:* + (23); *Lolium multiflorum:* 1 (23); *Malva neglecta:* + (23); *Prunella vulgaris:* + (23); *Veronica chamaedrys:* + (23).

Tab. 8 - Papaveretum apuli

Localities: 1: Lucinico 0047/3 (GO); 2: Farra d'Isonzo 0047/3 (GO); 3: Gradisca 0147/1 (GO); 4: S. Vito di Fagagna 9944/4 (UD); 5: Mereto di Tomba 9944/3 (UD); 6: Orzano (Remanzacco) 9946/2 (UD); 7: Palmanova 0045/4 (UD); 8: Fagagna 9844/4 (UD); 9: Cerneglons 9954/2 (UD); 10: Udine 9945/2; 11: Udine Sud 9945/2 (UD); 12: Premariacco 9946/2 (UD); 13: Cervignano 0146/4 (UD); 14: Carlino (Marano) 0145/3-0245/1 (UD); 15: Torviscosa 0145/4 (UD); 16: Pradamano 9945/2 (UD); 17: Cicconicco di Fagagna 9844/3 (UD);

Sporadic species: *Potentilla reptans:* + (1), 1 (13), 1 (14); *Rumex crispus:* + (1), + (6), 1 (15); *Reseda lutea:* + (4), + (10), + (12); *Rumex obtusifolius:* 1 (8), + (9), 1 (11); *Rubus caesius:* + (13); + (14), + (15); *Medicago sativa:* 2 (4), 3 (6); *Ajuga genevensis:* + (5), 1 (11); *Plantago major:* + (6), 1 (9); *Helianthus tuberosus:* 1 (7), 1 (14); *Cerastium holosteoides:* + (10), + (17); *Taraxacum officinale:* 1 (10), + (17); *Saxifraga tridactylites:* + (11), + (16); *Acinos arvensis:* + (11), + (12); *Fagopyrum tataricum:* 1 (1); *Achillea millefolium:* 1 (2); *Melilotus officinalis:* + (2); *Trifolium pratense:* + (2); *Vicia cracca:* + (2); *Aphanes arvensis:* 1 (3);

Bifora radians: + (3); *Lithospermum officinale:* 4 (3); *Diplotaxis tenuifolia:* + (4); *Fallopia dumetorum:* 1 (4); *Galium mollugo:* + (4); *Arrhenatherum elatius:* + (5); *Glechoma hederacea:* + (5); *Myosoton aquaticum:* + (5); *Rumex acetosa:* + (5); *Bidens frondosa:* 1 (7); *Geum urbanum:* + (7); *Brassica oleracea:* + (8); *Humulus lupulus:* + (9); *Oxalis acetosella:* + (9); *Hypochoeris radicata:* + (10); *Senecio inaequidens:* 1 (10); *Galium lucidum:* 1 (11); *Plantago lanceolata:* 1 (11); *Saponaria officinalis:* 1 (11); *Verbena officinalis:* + (11); *Aegopodium podagraria:* 2 (13); *Equisetum ramosissimum:* + (14); *Festuca arundinacea:* + (14); *Plantago media:* 1 (14); *Lysimachia vulgaris:* + (15); *Dactylis glomerata:* + (16); *Erophila verna:* + (16); *Leucanthemum vulgare:* + (16); *Trifolium campestre:* + (16); *Crepis foetida:* 1 (17); *Rumex conglomeratus:* + (17).

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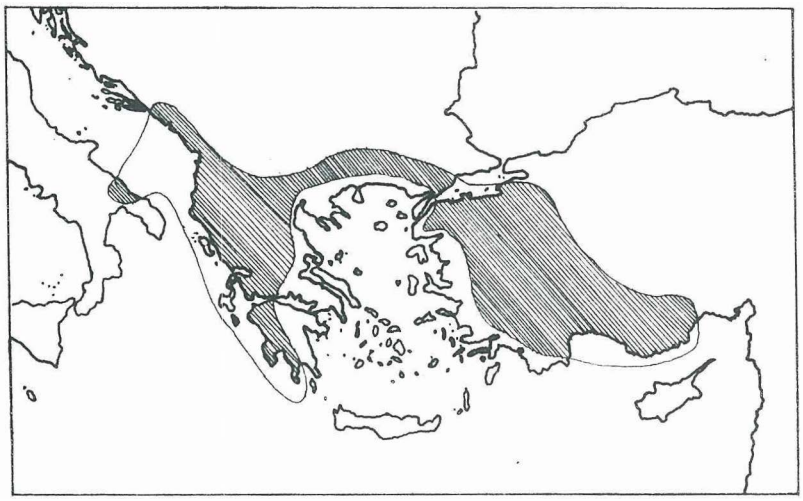

Fig. 1 - Distribuzione geografica di *Quercus trojana* Webb.
Geographic distribution of Quercus trojana *Webb.*

Area di studio

Sotto il profilo bioclimatico l'area pugliese interessata dai fragneti (Fig. 2) rientra, secondo la classificazione proposta da Rivas-Martinez *et al.* (1991), nel tipo mesomediterraneo subumido inferiore. Infatti sulla base dei diagrammi ombrotermici (Fig. 3), relativi alle stazioni termopluviometriche ricadenti all'interno dell'areale del fragno, si rileva che le temperature medie annue sono comprese fra 14°C e 16°C, mentre le precipitazioni medie annue vanno da circa 600 mm a 700 mm. *Quercus trojana* nel territorio pugliese si insedia normalmente su terre rosse mediterranee originatesi da calcari miocenici, dove forma boschi puri o talora misti a *Quercus ilex* L. e *Q. virgiliana* (Ten.) Ten., o più raramente a *Q. cerris* L. e *Q. calliprinos* Webb.

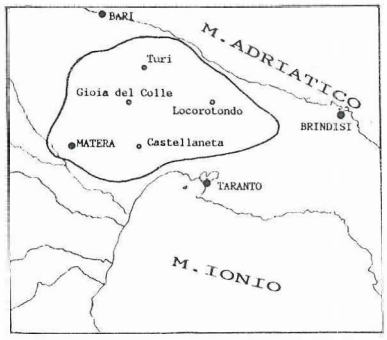

Fig. 2 - Areale di *Quercus trojana* Webb in Puglia (da Maselli 1940, modif.).
Distribution of Quercus trojana *in Puglia (from Maselli 1940, modified).*

Risultati e Discussione

Sulla base della loro composizione floristica, esigenze ecologiche e correlazioni dinamiche, i boschi a *Quercus trojana* presenti nelle Murge pugliesi mostrano un chiaro carattere termofilo. Infatti in queste formazioni sono presenti numerose sclerofille arboree, arbustive e lianose come *Quercus ilex, Phillyrea latifolia, Rubia longifolia, Rosa sempervirens, Lonicera implexa, Pistacia lentiscus, Viburnum tinus, Ruscus aculeatus*, ecc. che normalmente si accompagnano ad altri elementi termofili decidui come *Pyrus amygdaliformis, Calicotome infesta, Lonicera etrusca, Fraxinus ornus, Quercus virgiliana*, e *Pistacia terebinthus*.

Nel loro complesso questi fragneti, rientranti nella fascia climacica del *Quercion ilicis*, si insediano su substrati calcarei a quote comprese tra i 100 e i 500 m, dove costituiscono un tipo di vegetazione climacica molto peculiare ed esclusiva in Italia di quest'area pugliese. Abbastanza ricco e ben rappresentato è il contingente di specie appartenenti alla suddetta alleanza e alla relativa classe *Quercetea ilicis*. Oltre alle specie legnose sopracitate, si rinvengono pure numerosi altri elementi di questi *syntaxa*, come *Cyclamen repandum, Carex distachya, Asparagus acutifolius, Viola dehnhardtii, Luzula forsteri, Poa sylvicola, Tamus communis, Carex hallerana*. Per la caratterizzazione floristica dei suddetti *syntaxa* ci si è attenuti soprattuto al lavoro di revisione di *Quercetea ilicis* effettuato da Rivas Martinez (1975) e Brullo & Marcenò (1985).

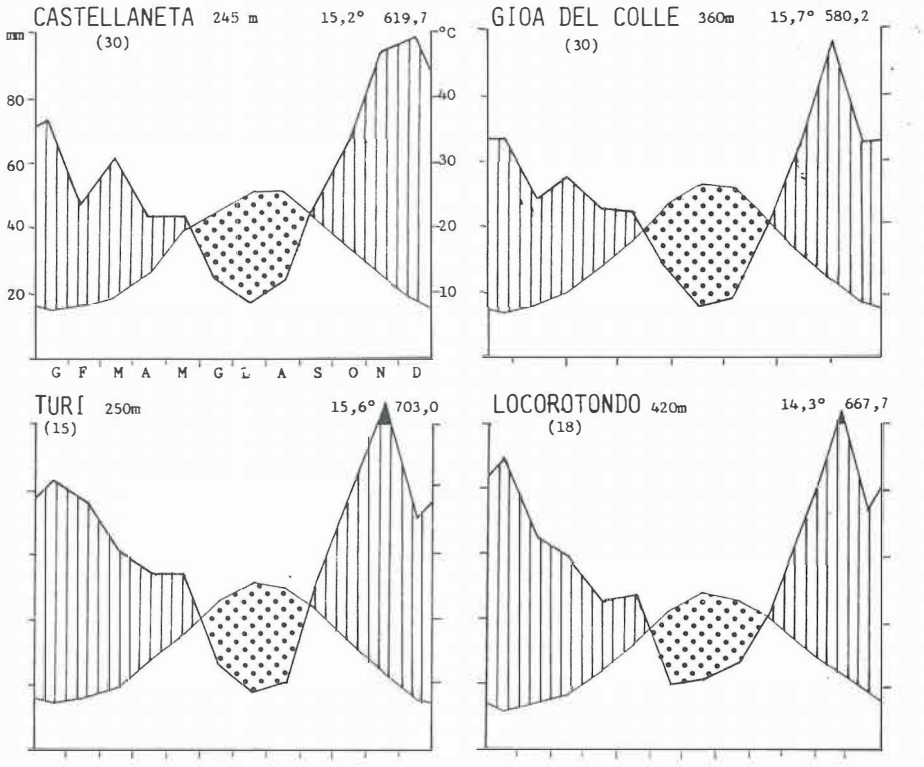

Fig. 3 - Diagrammi ombrotermici di alcune stazioni delle Murge Pugliesi. I dati di Castellaneta e Gioia del Colle sono stati tratti da Bianco *et al.* (1988); quelli di Turi e Locorotondo da Bianco (1961a).

Climatic diagrams of selected localities in the Murge (Puglia). Data from Bianco et al. *(1988) (Castellaneta and Gioia del Colle), and from Bianco (1961a) (Turi and Locorotondo).*

L'appartenenza di questa formazione all'alleanza *Quercion ilicis* era già stata evidenziata da Chiesura Lorenzoni *et al.* (1971) e successivamente confermata da Lorenzoni e Chiesura Lorenzoni (1987), che in particolare attribuiscono le cenosi in oggetto ad un *Quercetum trojanae n.n.*, in seno al quale differenziano varie subassociazioni.

In effetti, i fragneti delle Murge pugliesi si differenziano abbastanza bene floristicamente dalle altre formazioni boschive del *Quercion ilicis*, oltre che per la dominanza di *Quercus trojana*, anche per la presenza di alcuni elementi abbastanzi rari e significativi nel territorio italiano, esclusivi o quasi di queste formazioni. Si tratta in particolare di *Euphorbia apios* e *Potentilla detommasii*, specie entrambe del Mediterraneo nord-orientale, qui abbastanza diffuse e frequenti, come pure di *Arum apulum,* un raro endemismo pugliese. Queste specie nel loro complesso permettono di differenziare una nuova associazione, proposta come *Euphorbio apii-Quercetum trojanae* (*holotypus*: ril. 11, Tab. 1).

In situazioni microclimatiche e pedologiche più mesiche i boschi a *Q. trojana* della Puglia si arricchiscono in specie dei *Quercetalia pubescentis-petraeae* e dei *Querco-Fagetea*, fra cui in particolare *Buglossoides purpureo-coerulea, Silene italica, Euonymus europaeus, Poa sylvicola, Brachypodium sylvaticum, Quercus cerris, Fraxinus ornus.* Queste specie permettono di differenziare un aspetto più mesofilo proposto come subass. *poetosum sylvicolae* (*holotypus* ril. 10, Tab. 1), che si distingue abbastanza bene dal tipo anche sotto il profilo ecologico.

Sulla base di osservazioni personali inedite e di dati di letteratura (Agostini 1967, Macchia 1987, Bartolo *et al.* 1985, De Marco & Caneva 1985, Brullo *et al.* 1987), nel territorio pugliese l'associazione in oggetto viene sostituita in situazioni più xeriche dall'*Oleo - Quercetum virgilianae* Brullo 1984, che in genere è legato a un clima di tipo termomediterrano subumido inferiore, o dal *Thymo-Pinetum halepensis* De Marco & Caneva 1985 quando si passa al termomediterraneo secco superiore. In situazioni microclimatiche più

Tab. 1 - *Euphorbio apii - Quercetum trojanae*

Numero del rilievo	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Quota (m)	320	320	320	310	310	310	420	450	440	440	450	450	430	380	360
Superficie (m^2)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Copertura arborea (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Copertura arbustiva (%)	40	40	30	50	50	40	60	60	70	50	50	50	50	60	60
Copertura erbacea (%)	40	30	30	50	30	50	60	60	50	60	60	70	70	70	60
Specie caratteristiche di associazione															
Quercus trojana Webb	4	5	5	4	5	5	5	5	5	5	5	5	5	3	4
Euphorbia apios L.	1	1	2	1	1	+	2	1	1	2	1	1	1	2	1
Potentilla detommasii Ten.	.	+	.	+	1	.	.	+	2	1	1	1	+	1	2
Arum apulum (Carano) Bedalov	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Specie differenziali di subassociazione															
Poa sylvicola Guss.	.	.	.	.	.	.	2	1	1	2	2	2	2	3	2
Euonymus europaeus L.	.	.	.	.	.	.	.	+	1	2	2	1	1	1	2
Buglossoides purpurocaerulea (L.) Johnst.	1	+	.	.	.	+	1	.	.	2	2	2	1	2	1
Brachypodium sylvaticum (Hudson) Beauv.	.	.	.	.	.	.	2	1	2	2	2	2	3	.	.
Geum urbanum L.	.	.	.	.	.	.	.	+	1	1	1	1	+	.	+
Galium odoratum (L.) Scop.	.	.	.	.	.	.	+	1	+	1	+	.	.	.	.
Fraxinus ornus L.	.	.	.	.	.	.	.	1	1	1	+	.	.	.	.
Quercus cerris L.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2
Specie caratteristiche di *Quercion ilicis* e di *Quercetea ilicis*															
Rubia longifolia Poiret	1	2	2	2	1	1	.	2	2	2	2	1	1	1	1
Rosa sempervirens L.	1	1	+	+	.	1	.	1	1	1	2	2	2	2	2
Carex distachya Desf.	1	1	+	1	+	.	.	1	+	1	1	1	1	3	2
Pyrus amygdaliformis Vill.	1	1	+	1	+	.	.	+	2	1	2	1	1	.	1
Asparagus acutifolius L.	1	2	+	2	2	2	.	.	.	.	2	1	1	1	1
Quercus virgiliana (Ten.) Ten.	1	1	.	+	.	1	1	.	.	1	1	1	1	2	2
Phillyrea latifolia L.	1	+	1	1	+	1	2	1	1	+	1	.	.	.	.
Lonicera etrusca Santi	.	.	+	1	+	.	.	1	1	1	1	1	+	1	1
Quercus ilex L.	2	1	1	2	2	1	1	+	1	.	.	.	.	.	.
Cyclamen repandum Sibth. et Sm.	1	+	1	.	+	.	.	.	.	2	1	1	1	+	.
Viola dehnhardtiiTen.	+	+	.	+	.	+	.	.	.	.	1	1	+	+	+
Calicotome infesta (C.Presl) Guss.	1	.	+	2	1	1	.	2	1	1	.	.	.	.	.
Ruscus aculeatus L.	.	.	.	.	.	.	.	.	1	1	1	2	1	1	+
Tamus communis L.	.	.	.	.	.	.	2	1	2	1	1	1	.	.	.
Lonicera implexa Aiton	.	.	.	.	.	.	1	2	1	.	.	.	1	1	.
Luzula forsteri (Sm.) DC.	+	.	+	1	+	.	.	.	.	.	.	.	.	+	.
Pistacia lentiscus L.	.	.	.	.	.	.	3	2	2	.	.	.	.	.	.
Pistacia terebinthus L.	.	.	.	.	.	.	.	.	.	.	1	2	1	.	.
Viburnum tinus L.	.	.	.	.	.	.	1	1	1	.	.	.	.	.	.
Carex hallerana Asso	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.
Pulicaria odora (L.) Reichenb.	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.
Altre specie															
Ranunculus neapolitanus Ten.	2	1	1	1	.	1	1	1	1	2	1	1	2	1	+
Crataegus monogyna Jacq.	1	+	1	1	.	+	1	1	2	1	1	1	1	1	2
Dactylis glomerata L.	1	.	+	1	.	2	2	1	1	2	2	2	2	2	2
Geranium sanguineum L.	1	.	+	1	1	2	1	+	+	.	1	1	+	1	+
Silene italica (L.) Pers.	+	1	+	1	1	+	1	.	.	.	1	2	1	2	2
Allium subhirsutum L.	+	+	+	1	1	+	.	.	1	+	1	+	+	.	.
Hedera helix L.	1	+	.	.	1	.	.	2	1	1	2	2	2	2	1
Stachys cfr. salviifolia Ten.	1	+	.	+	1	+	1	.	.	.	+	+	+	+	+
Carex serrulata Biv.	+	.	+	1	+	+	.	.	+	.	+	.	+	1	+
Crepis leontodontoides All.	1	+	.	+	+	.	2	.	.	.	+	1	.	1	1
Rubus ulmifolius Schott	1	+	+	1	2	1	.	3	.	.	.	.	.	1	2
Euonymus europaeus L.	.	.	.	.	.	.	.	+	1	2	2	1	1	1	2
Crepis vesicaria L.	.	.	.	.	.	.	2	1	1	+	1	1	+	.	1
Anthoxanthum odoratum L.	1	+	.	+	.	.	.	.	.	.	1	1	1	1	+
Arabis hirsuta (L.) Scop.	.	.	.	.	.	.	+	+	+	+	1	1	1	.	+
Teucrium chamaedrys L.	+	+	.	+	.	+	.	.	.	.	+	.	+	1	+
Prunus spinosa L.	.	.	.	.	.	.	.	1	1	1	1	+	.	2	2
Anemone hortensis L.	.	.	.	.	.	.	.	+	1	.	1	+	1	+	+
Festuca rubra L.	.	.	+	2	+	.	1	.	.	.	.	.	.	2	1
Asphodelus microcarpus Salzm. et Viv.	.	.	.	.	.	.	2	.	.	.	+	1	1	2	+
Cistus monspeliensis L.	1	1	+	1	+	.	2	.	.	.	.	.	.	.	.
Sanguisorba muricata Gremli	.	.	.	+	.	.	.	.	1	+	1	1	+	.	.
Silene latifolia Poiret	.	.	.	.	.	.	.	.	+	.	+	1	1	+	+
Cistus eriocephalus Viv.	1	+	.	.	.	+	.	1	+	.	.	.	.	.	.
Dorycnium hirsutum (L.) Ser.	1	+	+	.	.	.	1	.	.	.	.	.	.	.	.
Silene vulgaris (Moench) Garcke	.	.	.	.	.	.	1	1	+	.	+	.	.	.	.
Galium verum L.	+	+	.	.	.	.	.	.	.	.	.	.	.	+	1
Leontodon tuberosus L.	.	.	.	.	.	.	+	.	.	.	.	.	+	1	+

fresche e umide, come il fondo di valloni o versanti bene ombreggiati, in genere si insediano leccete mesofile del *Quercion ilicis* riferibili in massima parte al *Pistacio-Quercetum ilicis* Brullo & Marcenò 1985. Nell'estrema punta salentina, limitatamente alle aree più interne, interessate da un bioclima termomediterraneo subumido superiore, la formazione climatofila è rappresentata dall' *Arbuto-Quercetum calliprini* Brullo *et al.* 1987. Abbastanza diffuse lungo le stazioni costiere della Puglia sono inoltre le formazioni dell' *Oleo-Ceratonion*, appartenenti per lo più al *Myrto-Lentiscetum* (Molinier 1954 em. O. Bolos 1962) Rivas Martinez 1975.

Da osservazioni personali inedite, nei processi di degradazione, legati soprattutto al taglio, incendio e pascolo, l'*Euphorbio apii-Quercetum trojanae* tende ad essere sostituito, in seguito alla distruzione dello strato arboreo ed arbustivo, da garighe del *Cisto-Ericion* Horvatić 1958, che a loro volta, con l'accentuarsi dei fenomeni di erosione del suolo, lasciano il posto a praticelli effimeri del *Thero-Brachypodion* Br.-Bl. 1925.

Sulla base dei dati di letteratura, boschi a *Quercus trojana* sono stati segnalati nella Penisola Balcanica da Horvat *et al.* (1974), che riportano per la Macedonia un *Quercetum trojanae* Em 1958 em. Horvat 1959 attribuito all' *Ostryo-Carpinion orientalis* Horvat (1954) 1958, alleanza dei *Quercetalia pubescentis* Br.-Bl. 1932. Questa associazione, per la presenza e in genere abbondanza di *Carpinus orientalis, Ostrya carpinifolia, Sorbus aria, Acer obtusatum, Quercus pubescens, Fraxinus ornus, Coronilla emeroides, Buxus sempervirtens, Cornus mas, Festuca heterophylla, Campanula trachelium, Polygonatum odoratum*, ecc., come pure per le sue esigenze ecologiche, mostra un marcato carattere mesofilo e pertanto si differenzia nettamente dall'associazione pugliese. Altre associazioni a *Quercus trojana*, ascritte sempre all' *Ostryo-Carpinion orientalis*, sono state segnalate per varie località dell'ex Yugoslavia. Si tratta in particolare del *Quercetum pubescenti-macedonicae* Horvat 1936 *n.n.*, *Quercetum trojanae hercegovinicum* Stefanović 1962 *n.n.*, *Quercetum trojanae montenegrinum* Blečić & Lakusić 1975 *n.n.*, *Quercetum macedonicae* Em in Horvat 1950 *n.n.* (cfr. Horvat 1936, 1950, Fukarek & Fabijanić 1968, Stefanović & Fabijanić 1969, Em 1969). Queste associazioni non possono essere comparate dal punto di vista floristico con quella pugliese in quanto i vari autori citano semplicemente il nome dell'associazione senza fornire rilievi o elenchi floristici. E' comunque da ritenere probabile che boschi termofili a *Quercus trojana* affini a quelli pugliesi, rientranti anch'essi nel *Quercion ilicis* siano presenti anche nei territori balcanici e anatolici, soprattutto nelle stazioni collinari più meridionali.

Appendice 1

Rill. 1-6: Tra Putignano e Alberobello (Bari), 8.5.84; ril. 7 Bosco delle Pianelle (Taranto), 7.5.1992; rill. 8-10: Martinafranca (Taranto), 7.5.1992; rill. 11-13: Alberobello (Bari), 7.5.1992; rill.14-15 Gioia del Colle (Bari), 7.5.1992.

Appendice 2

Specie sporadiche di Tab. 1 - Ril. 1: *Asperula aristata* L. Fil., *Briza maxima* L., *Hippocrepis varia, Oryzopsis miliacea* (L.) Asch. et Schweinf., *Pimpinella anisoides* Briganti, *Stachys arenaria* Vahl, *Thesium italicum* DC. Ril. 2: *Briza maxima* L., *Hippocrepis varia, Stachys arenaria* Vahl, *Thesium italicum* DC. Ril. 3: *Asperula aristata* L. Fil., *Pimpinella anisoides* Briganti, *Stachys arenaria* Vahl, *Saxifraga bulbifera* L. Ril. 4: *Geranium purpureum* Vill., *Lolium perenne* L., *Prunella vulgaris* L., *Saxifraga bulbifera* L. Ril. 6: *Briza maxima* L., *Geranium purpureum* Vill., *Lolium perenne* L., *Saxifraga bulbifera* L. ril: 7: *Cistus salviifolius* L., *Orchis morio* L., *Orchis papilionacea* L. Ril. 8: *Cistus salvifolius* L., *Festuca heterophylla* Lam., *Pteridium aquilinum* (L.) Kuhn Ril. 9: *Festuca heterophylla* Lam., *Pteridium aquilinum* (L.) Kuhn, *Platanthera chlorantha* (Custer) Rchb. Ril. 11: *Clinopodium arundanum* Boiss. Ril. 12: *Bromus erectus* Hudson, *Clinopodium arundanum* Boiss., *Hordeum bulbosum* L., *Ornithogalum comosum* L. Ril. 13: *Clinopodium arundanum* Boiss., *Festuca heterophylla* Lam., *Ornithogalum comosum* L.; *Pimpinella peregrina* L. Ril. 14: *Elaeoselinum asclepium* (L.) Bertol., *Galium aparine* L., *Ornithogalum comosum* L., *Pimpinella peregrina* L., *Quercus calliprinos* Webb, *Silene otites* (L.) Wibel, *Eryngium campestre* L., *Origanum heracleoticum* L. Ril. 15: *Pimpinella peregrina* L., *Quercus calliprinos* Webb, *Silene otites* (L.) Wibe, *Elaeoselinum asclepium* (L.) Bertol., *Galium aparine* L., *Thapsia garganica* L. *Genista sp.*, *Rhamnus oleoides* L.

Riassunto

In questo lavoro vengono esaminati i boschi calcicoli caratterizzati dalla dominanza di *Quercus trojana* presenti in Puglia. Dal punto di vista fitosociologico questa formazione rientra nel *Quercion ilicis,* alleanza dei *Quercetea ilicis,* localizzandosi nel territorio delle Murge a 100-500 m di quota. Si tratta di un'associazione climatofila legata a un bioclima di tipo mesomediterraneo subumido inferiore, la quale viene proposta come *Euphorbio apii-Quercetum trojanae.* Ne vengono esaminate la composizione floristica, l'ecologia, la distribuzione e le correlazioni sindinamiche.

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Rill. 1-6: Tra Putignano e Alberobello (Bari), 8.5.84; ril. 7 Bosco delle Pianelle (Taranto), 7.5.1992; rill. 8-10: Martinafranca (Taranto), 7.5.1992; rill. 11-13: Alberobello (Bari), 7.5.1992; rill.14-15 Gioia del Colle (Bari), 7.5.1992.

Appendice 2

Specie sporadiche di Tab. 1 - Ril. 1: *Asperula aristata* L. Fil., *Briza maxima* L., *Hippocrepis varia, Oryzopsis miliacea* (L.) Asch. et Schweinf., *Pimpinella anisoides* Briganti, *Stachys arenaria* Vahl, *Thesium italicum* DC. Ril. 2: *Briza maxima* L., *Hippocrepis varia, Stachys arenaria* Vahl, *Thesium italicum* DC. Ril. 3: *Asperula aristata* L. Fil., *Pimpinella anisoides* Briganti, *Stachys arenaria* Vahl, *Saxifraga bulbifera* L. Ril. 4: *Geranium purpureum* Vill., *Lolium perenne* L., *Prunella vulgaris* L., *Saxifraga bulbifera* L. Ril. 6: *Briza maxima* L., *Geranium purpureum* Vill., *Lolium perenne* L., *Saxifraga bulbifera* L. ril: 7: *Cistus salviifolius* L., *Orchis morio* L., *Orchis papilionacea* L. Ril. 8: *Cistus salvifolius* L., *Festuca heterophylla* Lam., *Pteridium aquilinum* (L.) Kuhn Ril. 9: *Festuca heterophylla* Lam., *Pteridium aquilinum* (L.) Kuhn, *Platanthera chlorantha* (Custer) Rchb. Ril. 11: *Clinopodium arundanum* Boiss. Ril. 12: *Bromus erectus* Hudson, *Clinopodium arundanum* Boiss., *Hordeum bulbosum* L., *Ornithogalum comosum* L. Ril. 13: *Clinopodium arundanum* Boiss., *Festuca heterophylla* Lam., *Ornithogalum comosum* L.; *Pimpinella peregrina* L. Ril. 14: *Elaeoselinum asclepium* (L.) Bertol., *Galium aparine* L., *Ornithogalum comosum* L., *Pimpinella peregrina* L., *Quercus calliprinos* Webb, *Silene otites* (L.) Wibel, *Eryngium campestre* L., *Origanum heracleoticum* L. Ril. 15: *Pimpinella peregrina* L., *Quercus calliprinos* Webb, *Silene otites* (L.) Wibe, *Elaeoselinum asclepium* (L.) Bertol., *Galium aparine* L., *Thapsia garganica* L. *Genista sp.*, *Rhamnus oleoides* L.

Riassunto

In questo lavoro vengono esaminati i boschi calcicoli caratterizzati dalla dominanza di *Quercus trojana* presenti in Puglia. Dal punto di vista fitosociologico questa formazione rientra nel *Quercion ilicis,* alleanza dei *Quercetea ilicis,* localizzandosi nel territorio delle Murge a 100-500 m di quota. Si tratta di un'associazione climatofila legata a un bioclima di tipo mesomediterraneo subumido inferiore, la quale viene proposta come *Euphorbio apii-Quercetum trojanae.* Ne vengono esaminate la composizione floristica, l'ecologia, la distribuzione e le correlazioni sindinamiche.

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ON THE PRESENCE OF PHYTOSTEROLS IN SOME SPECIES OF *EUPHORBIA* L.

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Keywords: Chemotaxonomy, *Euphorbia*, Friuli- Venezia Giulia, Phytosterols.

Abstract: In five species of *Euphorbia* of the Friuli-Venezia Giulia region (NE Italy) (*E. amygdaloides, E. cyparissias, E. helioscopia, E. fragifera* and *E. flavicoma* subsp. *verrucosa*) ten phytosterols were isolated and identified, by means of HPLC and spectroscopic tecniques, as β-sitosterol, stigmasterol, campesterol, colestan -3, 5, 6-triol, cycloartenol, squalene, stigmastanol, stigmasterol acetate, cholesterol and lanosterol. The ratio β-sitosterol/stigmasterol can be used to distinguish some of the species.

Introduction

The interest in plant sterols (phytosterols) has been growing over the last few years because of their biological importance. Numerous studies show that phytosterols are widespread, from the simplest organisms such as bacteria, algae and fungi (Chardon-Loriaux *et al.* 1976), to vascular plants, where they were isolated both in the vegetative and reproductive systems (Ingram *et al.* 1968). Recent studies have also identified them in the genus *Euphorbia* (Atallah & Nicholas 1972, Nielsen *et al.* 1979, Sekula & Nes 1980), together with various other secondary metabolites such as triterpenes, flavonoids, resins and essential oils. The highest concentrations were found in chloroplasts, microsomes and mitochondria, and in the plasma-lemma (Nes & Heftmann 1981), where they probably are structural elements of the membranes, regulating their stabilisation and the permeability (Grunwald 1968 and 1971). Studies were also carried out on the biosynthesis and the functions of phytosterols (Sharma 1970, Heftmann 1971) and of some derivatives, in particular steryl esters (Waller *et al.* 1981) and steryl glicosides (Smith 1969). Their concentration varies during the life cycle, as proved by the studies of Davis (1972) and Grunwald (1975) on tobacco, and of Ingram *et al.* (1968) on some *Cruciferae*. Germination (Bush & Grunwald 1972), growth (Geuns 1975), anthesis (Biswas *et al.* 1967) and senescence (Grunwald 1975) are significant stages in the biosynthesis of phytosterols, whose concentration is also influenced by environmental factors such as water availability, temperature (Davis & Finkner 1972) and light (Bush *et al.* 1971). Moreover, the concentration of sterols particularly increases during the germination of the seeds, which seems to be linked to the biogenesis of the membranes (Duperon 1971; Bush & Grunwald 1972).

According to some authors (Atallah *et al.* 1975), all plant tissues can potentially synthesize sterols, but the degree of biosynthesis depends on the type and on the age of the tissue (Geuns 1975). As regards the pharmacological properties of phytosterols, Gupta *et al.* (1980) demonstrated their anti-inflammatory and antipyretic properties. Experiments on their contraceptive effects, due to stigmast-5ene-3-7 diol and to stigmast-5ene-3, 7 diol isolated in leaves of *Ananas comosus*, were conducted on Guinea pigs by Pakrashi *et al.* (1975). Phytosterols also have antitumoral and cytotoxic (Miles *et al.* 1974), antihyper-colesteremic (Chandler *et al.* 1979), anticonvulsant (Farnsworth & Cordell 1976), antibacterial, antibechic and expectorant effects (Benoit *et al.* 1976).

Examined species

The genus *Euphorbia* comprises about 700 species and has a world-wide distribution (except Antarctica), especially in hot and dry areas. They are herbaceous annuals and perennials, suffrutescent plants and trees, mainly with simple leaves. Thermophythic elements prevail also among the almost thirty species of the flora of the Friuli-

Venezia Giulia region (Pignatti 1982, Poldini 1980, 1991), the highest concentration of the species being in the Karst area around Trieste and Gorizia, with a submediterranean climate (Poldini *et al.* 1991).

Our study is based on five among the most widespread species of the subgenus *Esula* Pers.: *E. amygdaloides* L. and *E. cyparissias* L., of the sect. *Esula*; *E. helioscopia* L., *E. fragifera* Jan and *E. flavicoma* DC. subspecies *verrucosa* (Fiori) Pign. of the sect. *Helioscopia* Dumort.

E. amygdaloides is found growing all over Europe (Meusel *et al.* 1978). In the Friuli-Venezia Giulia region it mainly occurs in the mountains, but it also occurs sporadically in the lowlands (Poldini 1991).

The distribution of *E. cyparissias*, originally limited to central-southern and south-eastern Europe has become wider because of anthropization, and it now extends to the United States and New Zealand (Hultèn & Fries 1986). In north-eastern Italy, it is very common in open, stony grasslands.

E. helioscopia, the only annual species considered, occurs in Europe and western Asia (Meusel *et al.* 1978). It is mainly found growing in synanthropic stands on loose, well-manured soil from sea level to about 1300 m.

The Illyrian endemic *E. fragifera* occurs from Montenegro to the Trieste Karst, where it is an important element of the sage garrigue. Two chemical varieties were distinguished in the Trieste Karst on the basis of essential oils composition. The different terpenoidic composition is probably correlated to different pollinators (Coassini Lokar *et al.* 1986).

Between the two intraspecies varieties of *E. flavicoma*, only subsp. *verrucosa*, with a Mediterranean-Pontic-Illyrian distribution, occurs in the Friuli Venezia-Giulia region (Pignatti 1982, Poldini 1991), usually in dry grasslands on limestone.

Data and Methods

Plant material - The samples (30 plants of each species at full anthesis) were randomly collected in the following areas of the Karst of Trieste (NE Italy): *E. amygdaloides*: Zolla di Monrupino and Mt. Orsario, 330 m; *E. cyparissias*: Opicina, 330 m; *E. fragifera*: Prosecco, 250 m; *E. flavicoma* subsp. *verrucosa*: between Gabrovizza and Sgonico, 260 m; *E. helioscopia*: Trieste, Scorcola, 100 m. Voucher specimens were deposited in the Herbarium of the Department of Biology, University of Trieste (TSB). Nomenclature follows Pignatti (1982).

Preparation of crude extracts - The samples (epigeal and aerial organs) were dried at 50°C until constant weight and pulverized under liquid nitrogen in a stainless steel ball-mill prior to extraction. 5 g of each pulverized sample accurately weighted and exaustively extracted according to the method proposed by Ghosh *et al.* (1985), were shaken again with a mixture of chloroform: methanol: water (30:60:30) in the ratio 5:120 p/V at room temperature (exaustion controll by preparative TLC). After centrifugation (20,000 rp/m for 10 min) the supernatant was separated from the methanolic phase with chloroform, evaporated *in vacuo* at 30°C; the residue was dissolved in 10 ml of n-hexane for HPLC in defined volumes (10 ml) and used directly for analysis. The purity and identity of the peaks in the crude extracts were controlled by UV spectra detection and compared with the standards (SIGMA Chem. Co., St. Louis, USA). The standards and the crude extracts were filtered on Millipore before the injection (7μ 1/10 ml of crude extract).

HPLC equipment - We used a Spectra Physic M-8750, Spectra Physic Programmer M 8700, septumless injector Model 8750, with a 10 μl sample loop, Bio Rad BIO-SIL-HP10 column (4×250 mm i.d. with BIORAD HP-10 pre-column, Spectra Physic SP Mod. 8840 wavelenght detector, multiple Mega Series (C. Erba, Milano, Italy) Computing integrator.

Operating conditions - Flow rate 1,5 ml/min, room temperature, detection UV 220 nm (detector sensivity 0.01 a.u.f.s.), PSI 150, chart speed 10 mm/min; all the determination were performed at room temperature (22°C) and at isocratic condition of elution. Standard deviation for retention times values 0.4-1.0 %; peak area reproducibility (for 5 analyses of standards) 1.9-3.1 %; mobile phase: n-hexane/ isopropanol/methanol (96:3.5:0.5 v/v).

Results

Ten of the phytosterols contained in aerial and hypogeal parts of the various samples of the five *Euphorbia* species considered were identified and quantified, as mean percentages (Tab.1): β-sitosterol, stigmasterol, campesterol, colestan -3β, 5α,

Tab.1 - Composition in phytosterols (% dry weight) in epigeal and hypogeal parts of the populations of the five species of *Euphorbia*.

Phytosterols	*E. amygdaloides*		*E. fragifera*		*E. helioscopia*		*E. cyparissias*		*E. verrucosa*	
	epig. %	hypog. %	epig. %	hypog. %	epig. %	hypog. %	epig. %	hypog. %	epig. %	hypog. %
β -sitosterol	88.95	84.61	93.97	79.53	79.90	71.92	64.28	50.30	83.50	37.95
stigmasterol	6.35	6.62	2.77	2.20	12.34	16.93	27.13	18.28	12.27	15.53
campesterol	2.20	2.53	1.94	3.09	3.09	4.21	5.01	6.78	1.78	6.49
colestan - 3 β, 5 α, 6 β - triol	1.17	2.14	-	3.65	2.41	1.75	-	20.32	0.28	9.63
cycloartenol	0.11	0.31	0.05	0.32	0.76	0.90	0.71	1.00	1.02	1.51
squalene	-	1.64	-	0.32	-	1.75	0.13	0.03	-	0.82
stigmastanol	-	-	0.05	0.58	0.83	1.27	2.62	2.91	1.07	1.33
stigmasterol acetate	1.22	2.15	1.22	-	-	-	-	-	-	16.07
cholesterol	-	-	-	0.19	-	-	-	-	-	-
lanosterol	-	-	-	-	0.04	-	-	-	-	-
Σ others unidentified	-	-	-	7.65	-	0.80	0.12	0.38	0.08	2.81

6β-triol, cycloartenol, squalene, stigmastanol, stigmasterol acetate, cholesterol and lanosterol. β-sitosterol, stigmasterol and campestrol are present both in epigeal and hypogeal organs, with β-sitosterol prevailing in the aerial parts. Stigmasterol is present in lower percentages, and generally prevails in the hypogeal parts with the exception of *E. fragifera* and *E. cyparissias,* which present the greatest percentages. Campesterol and cycloartenol are always most abundant in the hypogeal parts. Squalene, in very low quantities, was only found in the hypogeal parts of all samples. Stigmastanol is absent only in *E. amygdaloides* and tends to prevail in the hypogeal parts. Stigmasterol- acetate is scarcely represented, with the exception of the hypogeal parts of *E. verrucosa*. The hypogeal parts of *E. cyparissias* and *E. verrucosa* contained the highest percentages of colestan- 3β- 5α- 6β- triol.

Small quantities of lanosterol (in *E. helioscopia)* and of cholesterol (*E. fragifera)* were isolated. These triterpenic alcohols were also isolated by Falsone (1972) and Falsone & Schneider (1985) in *E. biglandulosa* Desf., together with their acetylic derivatives.

The relative position of the five species may be defined by the chemical variables, taken three by three. The analysis proved that they are discriminated only by the quantities of β-sitosterol, stig-masterol, Σ others in the hypogeal parts (Fig. 1A) and by the quantities of β-sitosterol, stigmasterol, campesterol in their epigeal organs (Fig. 1B).

If we examine the sterolic composition of the various plant organs, there is evidence that, as already established by Grunwald (1975), the ratio β-sitosterol/ stigmasterol in the hypogeal and aerial

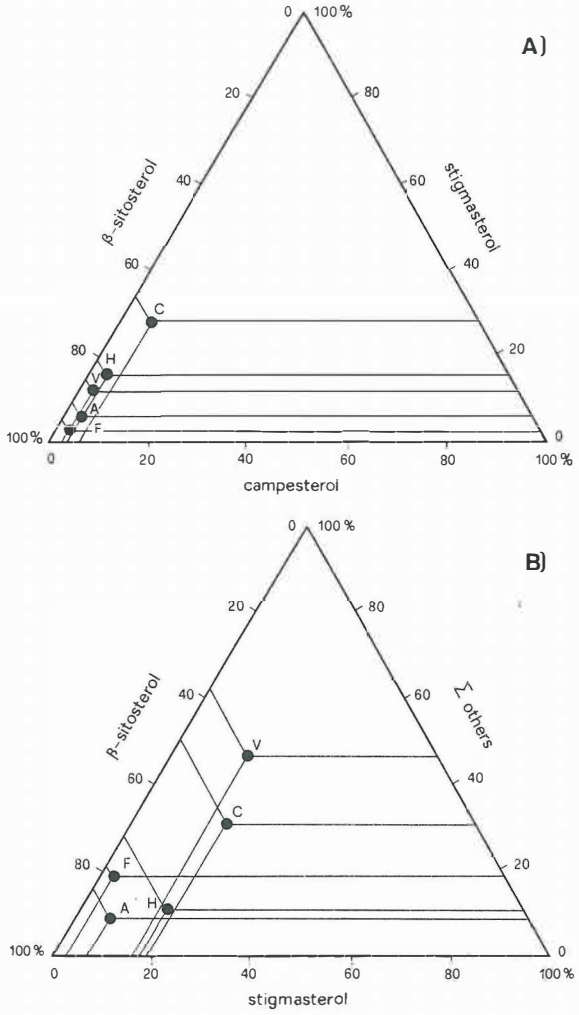

Fig. 1 - Triangular diagram showing the phytosterol discriminant combination of epigeal (A) and of hypogeal (B) organs of the five examined species (A = *E. amygdaloides*; C = *E. cyparissias*; F = *E. fragifera*; H = *E. helioscopia*; V = *E. verrucosa*).

Tab. 2 - Ratio β-sitosterol/stigmasterol in epigeal and hypogeal parts in the populations of the examined species of *Euphorbia*.

Species	β- sitosterol/stigmasterol	
	epigeal	hypogeal
E. fragifera	33.92	36.15
E. amygdaloides	14.00	12.76
E. helioscopia	6.47	4.25
E. verrucosa	6.27	2.44
E. cyparissias	2.37	2.75

parts (Tab. 2) is effective to distinguish the examined species. If both hypogeal and aerial organs are considered, *E. amygdaloides, E. fragifera* and *E. cyparissians* are clearly distinguished in their epigeal parts, while *E. amygdaloides* and *E. fragifera* are distinguished by the ratio value in the hypogeal parts. *E. helioscopia* and *E. verrucosa* are distinguishable only on the basis of the ratio value in the hypogeal parts.

Conclusions

This study was focused on the qualitative and quantitative presence of sterols in some populations of five *Euphorbia* species occuring in the Friuli-Venezia Giulia region, analyzed in their anthesis phase. It highlighted the high productivity of these biologically active compounds, and in particular of β-sitosterol, which tends to prevail in the green parts of the plants, especially in the leaves, where, on the other side, the biosyntesis takes place. Most of the identified sterols may play an active role in the florigenic activity, particularly β-sitosterol and lanosterol, whose concentration of 100 p.p.m. is sufficent to lead to flowering in 50% of the plants of *Chrysanthemum* (Biswas *et al.* 1967). The presence of single sterol derivatives was proved to be linked to developmental stages, and a particular value was attributed to the ratio β-sitosterol /stigmasterol (Grunwald 1975). In our study, the value of the ratio remains sufficiently constant in the populations, both in epi- and hypogeal parts, and may be utilized for the discrimination at population level. Lanosterol was only present in *E. helioscopia*, and therefore is a significant discriminant. Lanosterol and its ester derivatives, which are not usually present in plant extracts, are also typical of other *Euphorbiae* with a more southern distribution (Falsone 1972, Falsone & Schneider 1985); lanosterol and cycloartenol may result from the primary cyclization of squalene and are often found as acetylic derivatives, especially in latex. The 4-demethylsterols (β-sitosterol, campesterol and stigmasterol) prevail in the examined species, while saturated compounds (= stanols) are present in smaller amounts. Among steril-esthers, only stigmasterol-acetate was found.

It would be interesting to continue this analysis on other species of the genus, to define the composition of steroidic derivatives in plants and in latex alone, where ester derivatives and triterpenic alcohols seem to prevail, probably because of their highest solubility in water, which makes them less linked to the membrane processes. This could contribute to understand their role in various parts of the plant, and to establish the chemosystematic value of some of them inside the genus, or among other critical entities, such as *E. characias* and *E. wulfenii.*

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CHEMOSYSTEMATIC VALUE OF ARISTOLOCHIC ACIDS IN THE GENUS *ARISTOLOCHIA* L. IN FRIULI-VENEZIA GIULIA (NE ITALY)

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Keywords: *Aristolochia* L., aristolochic acids, chemotaxonomy, discriminant analysis.

Abstract: The composition of aristolochic acids from different populations of four *Aristolochia* species was analysed by HPLC; quantitative data were submitted to discriminant and statistical analyses. The interspecific variability was confirmed, and significant differences were detected by canonical discriminant functions. The aristolochic acid II and the ratio AAII/AAI are significant in the discrimination of the examined species.

Introduction

Aristolochia L. (*Aristolochiaceae)* is a well-known genus since the ancient times for its officinal properties. In Italy, several *Aristolochia* species have been widely used as medicinal plants since Plinius up to the last century (Savi 1805, Targioni-Tozzetti 1824, Cassone 1850). Ten species occur in Italy (Nardi 1984), four of which are present in the Friuli-Venezia Giulia Region: *A. clematitis* L., *A. rotunda* L., *A. pallida* Willd. and *A. lutea* Desf. (Gortani 1906, Poldini 1980, 1991, Martini 1990).

Characters related to the hypogean apparatus and the flowers have been considered as the most discriminant taxonomically (Nardi 1984). Nardi's revision was mainly based both on the frequently disregarded flower morphological characters and on chromosome numbers. Some species, i.e. *A. pallida* and *A. lutea*, are morphologically similar, and their determination on morphological evidence alone is difficult.

A previous study (Cateni *et al.* 1993), reported the chemical composition of various populations of *A. clematitis,* and the distribution of aristolochic acids in different parts of the plants, also with regard to the seasonal stages.

In this paper we examine the aristolochic acid composition of the underground apparatus of the *Aristolochia* species occurring in the Friuli-Venezia Giulia Region, which were not yet phytochemically investigated. The distinct properties of aristolochic acids among the species, and the evidence they provide on their mutual relationship were also considered.

The four species differ in their ecology. *A. clematitis* is the most autoapophytic, and grows in waste grounds along streams, ditches and sandy places near seashores, edges of cultivated fields, vineyards, hedges, rubble, margins of woods, coppices, on damp and aerated soils, rich in nitrates, up to 400 m. *Aristolochia rotunda* prefers damp grassy places along field margins, near ditches and streams, hedges, woods, shrubs, up to 400 m. *Aristolochia pallida* grows in woods, hedges, grassy places, mainly on plains and hills (up to 600 m). *Aristolochia lutea* is the taxon of the *A. pallida* complex with the widest distribution, and is also the most euritermic, growing mainly in *Ostrya carpinifolia*-woods (but also in beech woods), up to 1000 m. The distribution area of *A. pallida* includes the western part of the Region, while *A. lutea* is distributed in the eastern part; the northern populations of *A. lutea* co-exist with those of *A. pallida* and are often hardly distinguishable by morphological characters (Martini 1990).

The purpose of this study is to ascertain whether the four species can be distinguished on the basis of their aristolochic acids content, and to contribute further to the knowledge of aristolochic acids variation within the genus.

Materials and methods

Sampling concerned four populations of each species of *Aristolochia* in the following localities:
Aristolochia clematitis: 1) Gorizia, loc. Mainizza, 40 m; 2) Sgonico (TS), 255 m; 3) Polcenigo (PN), loc. S. Giovanni, 60 m; 4) Monfalcone (GO), loc. Alberoni, 2 m.
Aristolochia rotunda: 5) Muggia (TS), loc. Noghere, 5 m; 6) Muzzana del Turgnano (UD), loc. Bosco Coda di Manin, 6 m; 7) Latisana, Precenicco (UD), 3 m; 8) Monfalcone (GO), loc. Alberoni, 2 m.
Aristolochia pallida: 9) Polcenigo (PN), loc. Rui Bragam, 70 m; 10)Tramonti di Sotto (PN), loc. Stalle Spinespes, 590 m; 11) Peonis (UD), loc. Rio Sech, 400 m; 12) Jouf di Maniago (PN), 450 m.
Aristolochia lutea: 13) M. S. Leonardo (TS), 350 m; 14) Fernetti (TS), 360 m; 15) Ajdovščina (Slovenia), Trnovski Gozd, M. Kucelj, 650 m; 16) Maniago (PN), 400 m.

The plants were collected at full anthesis to examine the quantitative variability in the hypogean apparatus. In each population, five samples of ten wild plants were randomly collected and voucher specimens were deposited in the Herbarium Universitatis Tergestinae (TSB).

The hypogean parts were treated with liquid nitrogen, finely grounded (60 mesh) and weighed (1 g dry weight estimated on another sample). The extraction was carried out with 150 ml of methanol in Soxhlet to exhaustion. The extracts were evaporated in vacuum to small volume. The residue was redissolved in 10 ml methanol. The extracts were analysed by high performance liquid chromatography (HPLC) as described in a previous paper (Cateni *et al.* 1992). HPLC analyses were performed using a Perkin Elmer ODS RP-column filled with bonded octadecylsilane on silica (10 μm), flow rate 1,8 ml/min, detection 310 nm (detector sensitivity 0,01 a.u.f.s.) and methanol/water/acetic acid (80:20:1) as mobile phase. All the determinations were performed at 22° C and at isocratic condition of elution.

The analytical data were submitted to elaboration with statistical methods (Zar 1984, Lagonegro & Feoli 1985a, 1985b).

Results and discussion

The study and the experiment were considered a good test for application of aristolochic acid data to taxonomic problems in the genus *Aristolochia* which is currently under revision. All the populations of the four examined species contain in the underground apparatus the same aristolochic acids (AAI and AAII) in different quantities. The quantitative composition in AAI and AAII and their ratio value in the various populations and species are reported in Tab. 1.

Tab. 1 - Variation and discriminant analysis in aristolochic acids I and II (% dry weight) in the examined populations of Aristolochia.

Species	Populations	Aristolochic acids I (%)	Aristolochic acids II (%)	Ratio AAII/ AAI
A. clematitis	1	0.54	0.58	1.1
	2	0.25	0.24	1.0
	3	0.26	0.28	1.1
	4	0.42	0.54	1.3
	Average	0.37	0.41	1.1
	St. dev.	0.14	0.17	0.13
A. rotunda	5	0.09	0.09	1.0
	6	0.05	0.07	1.4
	7	0.07	0.09	1.2
	8	0.07	0.09	1.2
	Average	0.07	0.08	1.2
	St. dev.	0.02	0.01	0.17
A. pallida	9	0.05	0.16	3.1
	10	0.05	0.17	3.5
	11	0.06	0.19	3.4
	12	0.06	0.18	3.2
	Average	0.05	0.18	3.3
	St. dev.	0.003	0.02	0.2
A. lutea	13	0.04	0.1	2.4
	14	0.05	0.1	2.0
	15	0.04	0.1	2.2
	16	0.08	0.18	2.2
	Average	0.05	0.12	2.2
	St. dev.	0.017	0.04	0.16
Variable	Wilkslambda	F		Significance
AAI	0.1766	118.1		0
AAII	0.2697	68.6		0

The quantitative acid composition of *A. clematitis* L. is clearly distinct from those of the other investigated species, and all its populations are more productive, about two to ten times higher; furthermore, in all the populations (except n. 2) AAII prevails. The quantity of AAII in the population n. 16 (*A. lutea*) is similar to that of *A. pallida*. These samples were derived from an isolated locality inside the distribution area of *A. pallida*. The ratio between the two aristolochic acids in the four species is very different for *A. pallida*, *A. lutea* and the remaining species: for *A. clematitis* the mean value is 1.1, for *A. rotunda* 1.2, for *A. pallida* 3.3 and for *A. lutea* 2.2.

The analysis of variance was used to display

Tab. 2. - Analysis of variance of aristolochic acid I (left) and II (right) based on % dry weight in the populations of the four species of *Aristolochia* L. (*Ac = Aristolochia clematitis; Ar = A. rotunda; Ap = A. pallida; Al = A. lutea*).($F_{0.05.(3.16)}$ =3.24; DF=degree of freedom; F= variance ratio test; Q= statistics for Cohrans's Q test).

AA I

Species	Source of variation	Sum of squares	DF	Mean squares	F	Q
	Treatment	0.293	3	0.098	285.691	
	Error	0.005	16	0		
	Total	0.299	19			
	Ac-Ar				208.015	24.981
A. clematitis	*Ac-Ap*				192.511	24.032
	Ac-Al				35.083	10.259
	Ar-Ap				0.300	0.949
	Ar-Al				72.244	14.722
	Ap-Al				63.230	13.773
	Treatment	0.004	3	0.001	326.077	
	Error	0.001	16	0		
	Total	0.005	19			
	Ac-Ar				325.167	31.233
A.rotunda	*Ac-Ap*				75.288	15.023
	Ac-Al				67.132	14.191
	Ar-Ap				87.591	16.210
	Ar-Al				96.805	17.024
	Ap-Al				0.230	0.831
	Treatment	0	3	0	18.368	
	Error	0	16	0		
	Total	0	19			
	Ac-Ar				0.462	1.177
A.pallida	*Ac-Ap*				8.297	4.989
	Ac-Al				5.678	4.127
	Ar-Ap				12.673	6.166
	Ar-Al				9.377	5.304
	Ap-Al				0.248	0.862
	Treatment	0.004	3	0.001	342.908	
	Error	0	16	0		
	Total	0.004	19			
	Ac-Ar				11.837	5.959
A.lutea	*Ac-Ap*				1.606	2.195
	Ac-Al				269.599	28.439
	Ar-Ap				4.724	3.746
	Ar-Al				168.453	22.480
	Ap-Al				229.595	26.245

AA II

Species	Source of variation	Sum of squares	DF	Mean squares	F	Q
	Treatment	0.453	3	0.151	487.210	
	Error	0.005	16	0		
	Total	0.458	19			
	Ac-Ar				308.661	30.430
A. clematitis	*Ac-Ap*				242.963	26.998
	Ac-Al				4.956	3.856
	Ar-Ap				3.926	3.432
	Ar-Al				235.395	26.574
	Ap-Al				178.519	23.142
	Treatment	0.002	3	0.001	23.966	
	Error	0	16	0		
	Total	0.002	19			
	Ac-Ar				20.363	7.816
A.rotunda	*Ac-Ap*				1.006	1.738
	Ac-Al				0.698	1.447
	Ar-Ap				12.315	6.078
	Ar-Al				13.521	6.369
	Ap-Al				0.028	0.291
	Treatment	0	3	0.001	68.335	
	Error	0	16	0		
	Total	0	19			
	Ac-Ar				12.782	6.193
A.pallida	*Ac-Ap*				67.065	14.184
	Ac-Al				22.086	8.140
	Ar-Ap				21.290	7.992
	Ar-Al				1.264	1.947
	Ap-Al				12.179	6.045
	Treatment	0	3	0.008	920.049	
	Error	0	16	0		
	Total	0	19			
	Ac-Ar				0.043	0.360
A.lutea	*Ac-Ap*				0.043	0.360
	Ac-Al				613.250	42.892
	Ar-Ap				0.173	0.721
	Ar-Al				602.990	42.532
	Ap-Al				623.598	42.253

Tab. 3.- T Student's results for regression lines: centroids slopes and intercepts values. Df= 5, $\alpha < 0.05$. (*Ac= Aristolochia clematitis; Ar= A.. rotunda; Ap= A. pallida; Al= A. lutea).*

Species	Centroids		Slopes		Intercepts	
	T Student	Prob (%)	T Student	Prob (%)	T Student	Prob (%)
Ac - Ar	6.49	0.17	2.29	8.37	12.29	0.004
Ac- Ap	6.79	0.25	4.92	0.8	13.39	0.004
Ac- Al	7.09	0.21	2.78	4.97	13.36	0.004
Ar - Ap	11.51	0.03	13.66	0.02	9.24	0.02
Ar - Al	2.71	5.38	9.33	0.08	9.47	0.02
Ap - Al	3.28	3.04	6.36	0.31	11.20	0.001

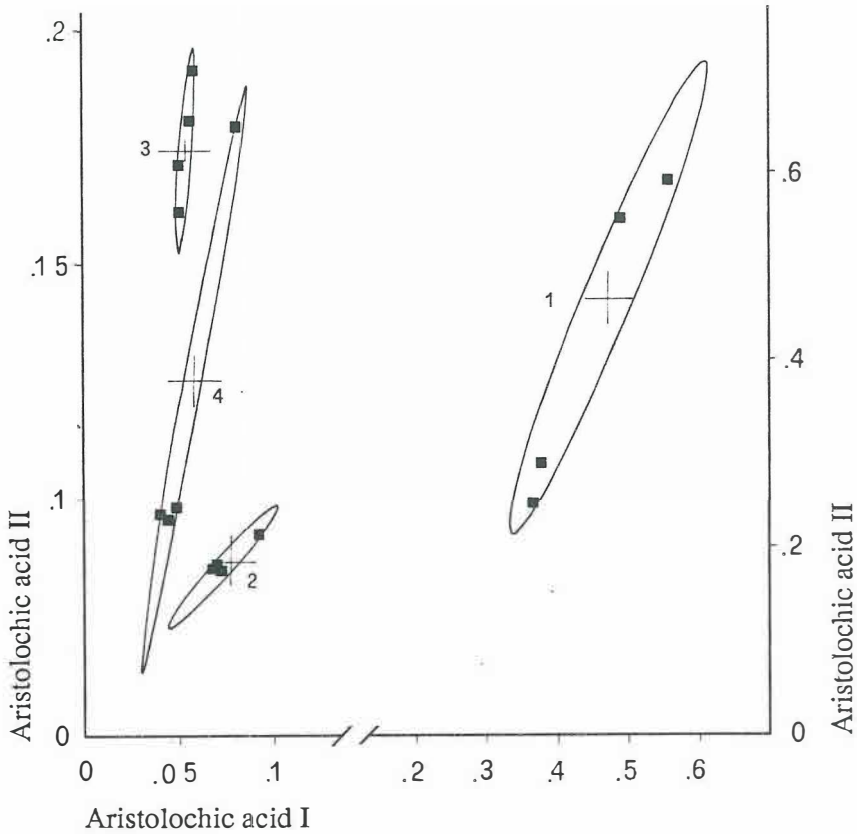

Fig. 1. - Ellipses of equal concentration, regression lines and centroids for the examinated *Aristolochia* species at the 5% level of confidence. The slopes and intercepts of the regression lines are significantly different ($p < 0.05$). 1: *A. clematitis*; 2: *A. rotunda*; 3: *A. pallida*; 4: *A. lutea*. The quantities are expressed as % dry weight.

the source of noticed variation among the four species. Statistically significant variation occurred for AAI and AAII. The most significant is AAI ($F = 118.1$) (Tab. 1). The results of the analysis of variance among populations are reported in Table 2. Because the critical value F is 3.14 at the 0.05 level of significance, all the values, which are smaller of 3.14, are not rejected. Therefore, *A. clematitis* populations are significatively distinct from those of the other species, in terms of both AAI and AAII. Statistically significant variations in the quantities of AAI occur among all the other populations of the various species. The populations of *A. lutea* significantly differ from those of *A. pallida*, although the two species are hardly distinguishable morphologically.

The four species can be discriminated by regression lines and centroid values of the aristolochic acids (Fig. 1). The values of centroid, slope and intercept are reported in Tab. 3. Most discriminant are the intercept and centroid values. The greatest disjunction is between *A. clematitis* and the other species.

Conclusions

The results demonstrate that aristolochic acids may be used for chemotaxonomical purposes in *Aristolochia*. The co-occurrence of structurally closely related compounds points to the chemical uniformity of the investigated species, differences being only quantitative. Aristolochic acid I and the ratio AAII/ AAI are the more significant taxonomically: chemical and morphological data are highly congruent.

Several questions regarding systematic relationships can be addressed using chemical data. The four *Aristolochia* species may be distinguishable from one another, based on aristolochic acid II data. Quantitative differences were compared: (a) among populations of different species, and (b) by combining the populations of each species to increase the sample size. The two closely related species, *A. pallida* and *A. lutea*, can be also distinguished on a chemical basis. It is confirmed that, chemically, *A. clematitis* is more distant one from the other species.

These results have implications both for basic research on plant populations and for applied studies on plant secondary products as defensive or attractive agents. The different concentrations of the same compounds in the populations and in the species suggest that they may have a specific biological role, and could be related both to their possible function as allelopathic agents (Nishida & Fukami 1989) and to their ecological role, since the plant toxins can be sequestred from the diet and stored by insects for defence. Aristolochic acids are actually used for this purpose by the butterfly *Battus archidamas* Boisd. (larval stage, Harborne 1987, 1988). It is interesting to note that in Friuli-Venezia Giulia, another butterfly, *Zerynthia polyxena* Schiff. (= *Z. hypsipyle* Schulz., *Papilionidae*) also feeds on *Aristolochia* (Morandini, *ex verbis*).

Riassunto

VALORE CHEMOSISTEMATICO DEGLI ACIDI ARISTOLOCHICI NEL GEN. *ARISTOLOCHIA* L. NEL FRIULI-VENEZIA GIULIA. La composizione in acidi aristolochici di differenti popolazioni appartenenti alle quattro specie di *Aristolochia* L. presenti nella regione Friuli - Venezia Giulia è stata analizzata tramite HPLC, analisi discriminanti e statistiche. La variabilità interspecifica è stata confermata e differenze significative sono state evidenziate tramite le funzioni canoniche discriminanti. Gli acidi aristolochici I e II e in particolare il rapporto AAII/AAI hanno valore di marcatori chemotassonomici data la congruenza fra dati chimici e morfologici.

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PHYTOSOCIOLOGICAL OBSERVATIONS ON THE BRYOLOGICAL VEGETATION OF MT. PALON (Mt. BONDONE GROUP, TRENTINO-ALTO ADIGE)

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Keywords: Alps, Bryophyte Communities, Mt. Palon, Trentino-Alto-Adige.

Abstract: Results of a study on bryophyte sociology in some localities of Mt. Bondone (eastern Italian Alps) are presented. Bryophyte associations observed in beech forests and *Pinus-mugo* scrubs are: *Orthotricho anomali-Grimmietum pulvinatae, Pseudoleskeelletum catenulatae, Ctenidietum mollusci, Solorino-Distichietum capillacei, Encalypto streptocarpae-Fissidentetum cristati* and *Pterigynandretum filiformis*, belonging to the *Tortulo-Homalothecietea sericei* class, and *Pleurozietum schreberi* of the *Hylocomietea splendentis* class.

Introduction

Although in the past Trentino-Alto Adige has been the focus of numerous bryological explorations and studies (Gerdol & Tomaselli 1991, Gerdol *et al.* 1991, Gerdol *et al.* 1994), very little is known about the bryovegetation of this region. Only fragmentary information is available on the following associations: *Barbuletea unguiculatae* Mohan 1978 (Cortini Pedrotti & Aleffi 1990), *Racomitrietea heterostici* Neumayr 1971 (Giacomini 1950), *Tortulo-Homalothecietea sericei* Hertel ex Mohan 1978 (Philippi 1983, Cortini Pedrotti 1994) and *Frullanio dilatatae-Leucodontetea sciuroidis* Mohan 1978 (Philippi 1983).

In particular, Monte Bondone was very little studied, information on its bryoflora being limited to publications by Venturi (1899) and Dalla Torre & Sarnthein (1904), while data on bryovegetation are given by only a single study on the Palinegra Bog near the "Le Viotte" Botanical Garden (Gerdol & Piccoli 1979).

In the summer of 1995, the Working Group for Bryology of the Italian Botanical Society conducted a floristic excursion in this area. The product of the excursion was a list of 142 species (29 liverworts and 113 mosses), 3 of which were new for Trentino-Alto Adige (Aleffi & Cortini Pedrotti 1996). The present work presents some aspects of the bryovegetation, sampled on that occasion.

Study area

The Monte Bondone Group extends along the orographic right of the Adige valley and reaches its highest point with the peak of Monte Cornetto (2179 m), that, together with the Doss d'Abramo and the Cima Verde, delimits to the south the wide Viotte valley, which is blanketed by a deep cover of morenic material. To the east of the Viotte is Monte Palon (2090 m) and to the west La Rosta (1832 m). All of these mountains are composed of sedimentary rocks, in particular Mesozoic limestones.

The climate of Mt. Bondone is of a pre-Alpine type; average annual precipitation, measured at the Viotte station at 1530 m, reaches 1167 mm and mean annual temperature is 5.9 °C. The rain distribution is equinoctial, with spring and autumn maxima.

The vegetation of the summit belongs to the montane and subalpine belts (Pedrotti 1981, Pedrotti *et al.* 1994). In the montane belt there is a lower montane horizon up to about 1000 m with beech forests of *Carici albae-Fagetum* Rübel 1930 ex Moor 1952 em. Lohm. 1953, and an upper montane horizon between 1000 and 1750 m, with beech forests of *Cardamino pentaphylli-Fagetum* Mayer 1974. The subalpine belt is characterized by *Pinus-mugo* scrubs prevalently of the *Sorbo chamaemespili-Pinetum*, an association which develops on calcareous substrata, but with humus-rich, acidic soils (Minghetti 1996); *Erico carneae-*

Pinetum prostratae Zöttl 1951 and *Rhododendro hirsuti-Pinetum prostratae* Zöttl 1951 grow on calcareous substrata with neutro-basic soils.

Material and methods

The phytosociological analysis has been carried out following the method of the Zürich-Montpellier School. Relevés were carried out on the slopes of Mt. Palon, on the east side, between ca. 1300 and 1500 m, corresponding to the *Cardamino pentaphylli-Fagetum,* and on the north-west side between ca. 1650 and 1800 m (La Cuna) in the *Sorbo chamaemespili-Pinetum mugo*. They are from dry and sunny to moist and shaded calcareous rocks, from soil in *Pinus mugo* scrubs, and from trunks of beech trees.

The syntaxonomic arrangement follows Marstaller (1993); nomenclature follows Corley *et al.* (1981) and Corley & Crundwell (1991) for mosses, and Grolle (1983) for hepatics; author's names are according to Crosby (1992) and Grolle (1983).

Syntaxonomical scheme

TORTULO - HOMALOTHECIETEA SERICEI Hertel ex Mohan 1978
- GRIMMIETALIA ANODONTIS Smarda 1947
- GRIMMION TERGESTINAE Smarda 1947
  - *Orthotricho anomali- Grimmietum pulvinatae* Stodiek 1937
  - *Pseudoleskeelletum catenulatae* Jezek & Vondràcek 1962
- CTENIDIETALIA MOLLUSCI Hadàc & Smarda in Klika & Hadàc 1944
  - CTENIDION MOLLUSCI Stefureac 1941
    - *Ctenidietum mollusci* Stodiek 1937
    - *Solorino- Distichietum capillacei* Reimers 1940
    - *Encalypto streptocarpae- Fissidentetum cristati* Neumayr 1971
- NECKERETALIA COMPLANATAE Jezek & Vondràcek 1962
  - NECKERION COMPLANATAE Smarda & Hadàc in Klika & Hadàc 1944
    - *Pterigynandretum filiformis* Hilitzer1925

HYLOCOMIETEA SPLENDENTIS Gillet ex Marstaller 1993
- PLEUROZION SCHREBERI v. Krusenstjerna 1945
  - *Pleurozietum schreberi* Wisniewski 1930

Results and discussion

Previous studies revealed the presence of some lithophilous and terricolous communities of the *Tortulo-Homalothecietea sericei* and *Hylocomietea splendentis* classes. Within the *Tortulo-Homalothecietea sericei*, widely distributed in central Europe, with many communities already known from Italy, associations of the *Grimmietalia anodontis* and *Ctenidietalia mollusci* were identified. In addition, an epiphytic aspect of the bryological vegetation was observed, and referred to the *Neckeretalia complanatae* order, belonging to the same class.

Within the *Hylocomietea splendentis* class, the *Pleurozietum schreberi* association (*Pleurozion schreberi* alliance), was identified. This class includes montane and alpine terri-saxicolous meso- or hygrophytic communities at high altitude; however, some of them are found in different habitats (waterfalls, rocks along roadsides, etc.). The *Hylocomietea splendentis* class, with the single order *Hylocomietalia splendentis*, was recently recognized by Marstaller (1993). Well known in central and northern Europe, this class is mentioned for the first time from Italy in this article.

Orthotricho anomali-Grimmietum pulvinatae Stodiek 1937

A xero- and photophytic, pioneer community found on exposed calcareous rocks in beech woods at ca. 1500 m (Tab. 1, rel. group A). It is dominated by *Orthotrichum anomalum*, an association guide species, and *Schistidium apocarpum*, an alliance guide species; some class character species join them, such as *Homalothecium sericeum, Ctenidium molluscum* and *Rhynchostegium murale*. Syntaxonomically, it comes under the *Grimmion tergestinae* alliance of the *Grimmietalia anodontis* order, a *syntaxon* of the mostly xero- and photophytic *Tortulo-Homalothecietea sericei* class.

Widely distributed in Central Europe (Hübschmann 1986), it has also been reported for the Iberian peninsula (Guerra & Varo 1981, Gil &

Guerra 1985, Fuertes Lasala & Martinez Conde 1988, Moya *et al.* 1994), northern and central Italy (Giacomini 1950, Hébrard 1978) and Sicily (Lo Giudice & Privitera 1987, Lo Giudice *et al.* 1992).

Pseudoleskeelletum catenulatae Jezek & Vondràcek 1962

A montane, saxicolous, xero-mesophytic, photo-sciophytic association, found in *Cardamino pentaphylli-Fagetum* forests, on calcareous rocks with no or little inclination (Tab. 1, rel. group B). It is found in less xeric and sunny habitats than those colonized by *Orthotricho anomali-Grimmietum pulvinatae.* This community is physionomically heterogeneous, due to the presence of both pleurocarpous and acrocarpous mosses, with both a turf and cushion habit. Character species is *Pseudoleskeella catenulata*, a xerophilous and mesophilous species with a boreal-montane/dealpine distribution (Düll 1984-1985). Species of higher syntaxa are *Schistidium apocarpum* and *Orthotrichum anomalum*, *Tortella tortuosa* and *Homalothecium sericeum.* This community is included in the *Grimmion tergestinae* alliance of the *Grimmietalia anodontis.*

The association has often been reported for central Europe (Jezek & Vondràcek 1962, Nörr 1970, Neumayr 1971, Hertel 1974, Marstaller 1980, 1992a, 1995). For southern Europe it is known from southeastern France (Hébrard 1971) and from the Iberian peninsula (Guerra 1985, Fuertes Lasala & Martinez Conde 1988). The association is new to Italy.

Solorino-Distichietum capillacei Reimers 1940

This association (Tab. 1, rel. group C) was found on the eastern and northwestern slopes of M. Palon, on fairly humid and shaded rocks; it prefers northern exposure. It substitutes *Pseudoleske-elletum catenulatae* in more mesic and shaded conditions.

Distichium capillaceum, a faithfully species, and *D. inclinatum*, a boreal-montane species, are characteristic of the association; they are accompanied by *Ctenidium molluscum, Campylium halleri*, which are alliance character species, and by several order species such as *Tortella tortuosa, Rhynchostegium murale, Encalypta streptocarpa, Schistidium apocarpum, Mnium thomsonii* and *Scapania aequiloba.* Floristically and ecologically, the association should be placed under the *Ctenidion mollusci* alliance of the *Cteniditalia mollusci* order, a syntaxon of the *Tortulo-Homalothecietea sericei* class, with scio- and mesophythic characters.

The distribution prevalently extends along the mountains of central Europe (von Hübschmann 1986, Marstaller 1987, 1991, 1992b); from southern Europe, this association was recently reported for some mountains of Sicily (Lo Giudice *et al.* 1992).

Ctenidietum mollusci Stodiek 1937

This community (Tab. 1, rel. group D) colonizes fairly shaded and humid calcareous rocks covered by a soil layer. Quite comon in the survey area, it behaves as an exocomophytic, clearly mesophilous and sciophilous association. It is characterized by *Ctenidium molluscum*, a circumboreal guide species, joined by many alliance and order character species. This association belongs in the *Ctenidion mollusci* alliance of the *Ctenidietalia mollusci* order. It is widespread in Central Europe (Hübschmann 1986), and has also been reported from former Yugoslavia (Hébrard 1975), the Iberian peninsula (Guerra & Varo 1981, Gil & Guerra 1985, Fuertes Lasala & Martinez Conde 1988) and Sicily (Lo Giudice *et al.* 1992, Privitera & Puglisi 1996).

Encalypto streptocarpae-Fissidentetum cristati Neumayr 1971

This chasmocomophytic, meso- and sciophytic community (Tab. 1, rel. group E) is frequently found both in beech woods and in *Pinus mugo* scrubs, where it colonizes fissures and concavities of the rocks, mostly covering small surfaces. *Fissidens dubius* (= *F. cristatus*) is an association character species. *Ctenidium molluscum*, an alliance character species, accompanies it, as some order and class character species, among which *Encalypta streptocarpa* and *Tortella tortuosa* are striking for their constancy and abundance. The association is included in the *Ctenidion mollusci* alliance of the *Ctenidietalia mollusci* order. It is known from Germany, Czechoslovakia, France, Spain (Vadam 1983, Ros & Guerra 1987) and, recently, from Sicily (Privitera & Puglisi 1996).

Pterigynandretum filiformis Hilitzer 1925

This association (Tab. 1, rel. group F) was found

Tab. 1 - Group A, relevés 1-5: *Orthotricho anomali-Grimmietum pulvinatae* . Group B, relevés 6-9: P*seudoleskeelletum catenulatae* . Group C, relevés 10-14: *Solorino - Distichietum capillacei. Group D,* relevés 15-21: *Ctenidietum mollusci.* Group E, relevés 22-25: *Encalypto streptocarpae-Fissidenteum cristati.* Group F, relevés 26-27: *Pterigynandretum filiformis.* Group G, relevés 28 - 32: *Pleurozie - tum schreberi.*

Relevé group	A	A	A	A	A	B	B	B	B	C	C	C	C	C	D	D	D	D	D	D	D	E	E	E	E	F	F	G	G	G	G	G
Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Area (sq. dm)	5	4	4	3	4	5	5	4	5	6	4	4	4	5	4	5	4	6	5	5	6	2	2	2	3	3	4	1	2	1	1	0,7
Altitude (m)	1500	1490	1515	1488	1507	1600	1630	1685	1710	1650	1510	1610	1575	1640	1700	1685	1650	1547	1530	1515	1505	1560	1585	1650	1700	1560	1590	1670	1710	1725	1740	1760
Coverage (%)	50	30	45	65	75	80	85	45	45	45	85	60	85	55	85	60	50	45	70	50	60	75	50	90	70	90	35	85	85	100	100	95
Inclimation	30	-	20	-	20	-	10	-	-	30	40	30	-	40	-	10	-	20	-	-	-	30	40	30	-	-	-	20	-	10	-	-
Exposure	S	-	SW	-	S	-	E	-	-	N	E	NW	-	W	-	N	-	E	-	-	-	E	NE	W	-	N	NW	N	-	NW	-	-
Species number	4	4	3	3	4	4	6	4	3	4	5	4	8	5	6	6	4	4	5	5	4	4	4	6	5	8	6	4	4	4	3	2
Orthotrichum anomalum	2	2	3	2	3		1	+																								
Schistidium apocarpum	2	1	+	3	3		3		1	1	1												1									
Homalothecium sericeum	1	1					1		1											2	+			1								
Rhynchostegium murale	1	+									+	3																				
Tortula ruralis						1																										
Brachythecium velutinum						+																										
Amblystegium serpens	1						2	+																								
Ctenidium molluscum				1	1						2	1			3	3	2	1	2	2	3	2		1	1			2				
Tortella tortuosa						2	1	1		2	3		2	+	2	1	2	1	2	1	+	1	2	+	1					1		
Pseudoleskeella catenulata						4	2	3	3																							
Distichium capillaceum										2	3	2	3	3	1				2													
Cirrhiphyllum cirrosum													2																			
Anastrophyllum minutum													1																			
Hypnum hamulosum													1																			
Plagiochila porelloides													1																			
Distichium inclinatum														1																		
Scapania aequiloba														1	+	1																
Mnium thomsonii														1			1															
Campylium halleri										1								+		1												
Campylium chrysophyllum															1																	
Anastrophyllum minutum																+																
Calypogeia neesiana																+																
Encalypta streptocarpa												1	1				1					2	2	4	2							
Fissidens dubius																			1	+	2	3	1	2	3							
Ditrichum flexicaule																		3	2													
Metzgeria furcata																								1								
Radula complanata					1																				1	2	+					
Pseudoleskeella nervosa																										3	1					
Bryum subelegans																										2	1					
Pterigynandrum filiforme (D)																										+	2					
Orthotrichum pumilum																										1						
Orthotrichum striatum																										1						
Hypnum cupressiforme																										1						
Hypn. cupr. ssp. resupinatum																										1						
Frullania dilatata																											+					
Plagiomnium cuspidatum																											1					
Hylocomium splendens															2	1												3	3	4	5	4
Pleurozium schreberi																												3	2		1	
Dicranum scoparium													+															1	2	1		
Rhytidiadelphus triquetrus																													2	2	1	2

sporadically on the trunks of beech trees. *Pseudoleskeella nervosa* and *Pterigynandrum filiforme*, respectively association character and differential species, dominate the community. *Plagiomnium cuspidatum,* is a N*eckerion complanatae* character species, joined by several corticolous species of the *Frullanio dilatatae-Leucodontetea sciuroidis* class, such as *Frullania dilatata, Radula complanata, Orthotrichum pumilum, O. striatum.* Synsystematically, Marstaller (1984) placed the association in the *Neckerion complanatae* of the *Neckeretalia complanatae*, a *syntaxon* in which he joined cortico-saxicolous and epiphytic associations. Even though our relevés would belong more to the *Frullanio dilatatae-Leucodontetea sciuroidis* class, we feel that for the moment Marstaller's suggested assignment should be followed. The community is distributed in many localities of central Europe, with maximum diffusion in the eastern and north-eastern parts; it extends to the Carpatians and the southern Alps, and, in northern Europe, as far north as southern Scandinavia (Marstaller 1992c). In Italy there are repots from Lombardy, Veneto and Trentino (Philippi 1983).

Pleurozietum schreberi Wisniewski 1930

This montane association (Tab. 1, rel. group G) was found on rocks covered by a thick stratum of humus-rich soil in fairly humid and shaded sites in the *Pinus mugo* scrubs, where it is quite common. It is composed of only a few mosses, almost all of which are of considerable size, its low biodiversity being counterbalanced by the high biomass, forming a more or less continuous blanket on wide surfaces. It could represent the most evolved stage among bryophyte communities of the understory of beechwoods and conifer woods of mountains with an alpine climate.

Hylocomium splendens, a sub-boreal moss, is considered as the association guide species; it is accompanied by the alliance character species *Pleurozium schreberi* and *Dicranum scoparium*, and by the class character species *Rhy-tidiadelphus triquetrus*. The few companion spe-cies are *Ctenidium molluscum* and *Tortella tor-tuosa*. The community belongs to the *Pleurozion schreberi* alliance of the *Hylocomietalia splen-dentis* order, in the *Hylocomietea splendentis* class. Described by Wisniewski (1930) for Poland, this association is also known from Thuringia (Marstaller 1994) and here it is reported for the first time for Italy. We also found it on M. Baldo above Rubiana (Verona) at about 850 m, within beech woods. In addition, some vegetational aspects identified by Giacomini (1939) in the Lombard Alps and cited generically as "*Hylocomietum*", could be attributed to the *Pleurozietum schreberi*.

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CATALOGUE OF LICHENIZED AND LICHENICOLOUS FUNGI OF CYPRUS

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Keywords: altitudinal zones, biodiversity, checklist, Cyprus, flora, lichenicolous fungi, lichenized fungi, lichens.

Abstract: This annotated checklist of lichens and lichenicolous fungi of Cyprus is based mainly on literature records. The currently known lichen flora is composed of 365 taxa (352 species of lichenized fungi, 2 subspecies, 3 varieties and 8 lichenicolous fungi). The Troodos Region, with about 230 taxa, is the part of the island with the highest number of known species. For each lichen species references, regions, substratum and altitudinal range are reported.

Introduction

The annotated catalogue of lichens and lichenicolous fungi of Cyprus provided here is based mainly on literature records, and is a first-approximation checklist compiled within the project of the OPTIMA Commission of Lichens for a general biodiversity inventory of the lichens of the Mediterranean area (Nimis 1996). The first lichen records from Cyprus were published by Flotow (1843), Koerber (1862) and Krempelhuber (1865). The records of Koerber (1862) and Krempelhuber (1865) were based on material collected by F. Unger. Recently, the lichen flora of Cyprus, especially in the Greek part, has received more attention (Aptroot 1996, Litterski 1997, Litterski & Mayrhofer 1998). Some regions in the Turkish part were investigated by Güvenc & Öztürk (1994, 1995).

The island of Cyprus is 9251 km^2 in size, and is situated in the south-eastern part of the Mediterranean Sea. The vegetation is of eu-Mediterranean type.

The currently known lichen flora comprises 365 taxa (352 species of lichenized fungi, 2 subspecies and 3 varieties of lichenized fungi, and 8 lichenicolous fungi). The Troodos Region, with about 230 taxa, and the Akamas-Pafos Region, with about 110 taxa, are the two parts of the island with the highest number of known species. Of the known species, 8% have *Trentepohliaceae* as phycobiont and occur mostly at lower altitudes, 84% have other green algae, and the remaining 8% have cyanobionts. The 352 species of lichenized fungi and 8 species of lichenicolous fungi belong to different orders, families and genera. Most of the species belong to the large order *Lecanorales* (222 species). Within the *Lecanorales* the *Physciaceae* (47 species), *Lecanoraceae* (35 species) and *Parmeliaceae* (36 species) are the families with the highest number of known species. Other important orders are the *Teloschistales* (43 species) and *Arthoniales* (22 species).

Methods and arrangement of the checklist

In the following checklist, species are listed alphabetically. For each lichen species, references, regions, substratum and altitudinal range are provided, so far as is possible. The references are listed in temporal order.

The following regions (Fig. 1) are reported in brackets:

I Akamas-Pafos Region
II Mamonia Region
III Troodos Region
IV Circum Troodos-Mesaoria Region
V Pentadyctolos Region

This delimitation corresponds with geological features (Geological Survey Department 1995). When it is not known where the locality mentioned in the literature is situated, the abbreviation ? is used.

The altitudinal zones are delimited as follows:

1996 (II), Litterski 1997 (I, III), Litterski & Mayrhofer 1998 (I, IV); pl/co, mo; ca, ro, si.

Caloplaca marmorata (Bagl.) Jatta - Litterski 1997 (III), Litterski & Mayrhofer 1998 (I); pl/co, salp; ca, si.

Caloplaca navasiana Nav.-Ros. & Cl. Roux - Navarro-Rosinés & Roux 1993 (IV), Navarro-Rosinés & Roux 1994 (fig. 1), Navarro-Rosinés & Roux 1995 (IV); pl/co; ca.

Caloplaca saxicola (Hoffm.) Nordin - Flotow 1843 (*Lecanora murorum y. callopisma*), Güvenc & Öztürk 1995 (V), Litterski 1997 (I, II); pl/co; ca, li.

Caloplaca subpallida H. Magn. - Aptroot 1996 (II, III); [pl/co, mo]; ro.

Caloplaca tavaresiana Nav.-Ros. & Cl. Roux - Navarro-Rosinés & Roux 1993 (IV), Navarro-Rosinés & Roux 1994 (fig. 1); pl/co; ca.

Caloplaca teicholyta (Ach.) J. Steiner - Aptroot 1996 (II), Litterski 1997 (I); pl/co; ro.

Caloplaca variabilis (Pers.) Müll. Arg. - Litterski & Mayrhofer 1998 (I); pl/co; ca.

Caloplaca veneris Cl. Roux & Nav.-Ros. - Roux & Egea 1992 (IV), Roux & Navarro-Rosinés 1992 (IV), Navarro-Rosinés & Roux 1993 (IV), Navarro-Rosinés & Roux 1994 (fig. 1); pl/co; ca.

Candelariella aurella (Hoffm.) Zahlbr. - Güvenc & Öztürk 1995 (V), Litterski 1997 (III), Litterski & Mayrhofer 1998 (I); pl/co, submo, salp; ca, Jn, Ps, si.

Candelariella vitellina (Hoffm.) Müll. Arg. - Aptroot 1996 (III), Litterski 1997 (III), Litterski & Mayrhofer 1998 (III); mo, salp; ro, si.

Candelariella xanthostigma (Ach.) Lettau - Aptroot 1996 (III); [mo]; Pi.

****Carbonea vitellinaria*** (Nyl.) Hertel - Litterski & Mayrhofer 1998 (III); salp; si, on *Candelariella vitellina.*

Catapyrenium daedaleum (Kremp.) Stein - Aptroot 1996 (II, III), Litterski 1997 (I, III); pl/co, submo; so.

Catapyrenium psoromoides (Borrer) R. Sant. - Litterski & Mayrhofer 1998 (III); submo; Qu.

Catillaria chalybeia (Borrer) A. Massal. - Aptroot 1996 (III), Litterski & Mayrhofer 1998 (I); pl/co, [mo]; sa, ro.

Catillaria lenticularis (Ach.) Th. Fr. - Litterski & Mayrhofer 1998 (I); pl/co; ca.

****Catillaria mediterranea*** Hafellner - Litterski & Mayrhofer 1998 (III); mo; Cd, on *Physcia semipinnata* and *Physcia stellaris.*

Catillaria nigroclavata (Nyl.) Schuler - Litterski 1997 (III); mo; cone (Pi).

Chromatochlamys muscorum (Fr.) H. Mayrhofer & Poelt - Litterski & Mayrhofer 1998 (III); mo; mos.

Cladonia cariosa (Ach.) Spreng. - Litterski 1997 (III); mo; Pi.

Cladonia cervicornis (Ach.) Flot. - Krempelhuber 1865 (IV), Litterski & Mayrhofer 1998 (I, III); pl/co; so.

Cladonia convoluta (Lam.) Anders - Flotow 1843 (*C. endiviaefolia*), Krempelhuber 1865 (IV, V, *C. endivifolia*), Güvenc & Öztürk 1994 (IV, V), Litterski 1997 (I, III); pl/co, submo; so.

Cladonia fimbriata (L.) Fr. - Güvenc & Öztürk 1994 (IV), Litterski 1997 (III); pl/co, mo; Pi.

Cladonia foliacea (Huds.) Willd. - Güvenc & Öztürk 1994 (IV, V); pl/co; so.

Cladonia furcata (Huds.) Schrad. - Flotow 1843; -; -.

Cladonia pocillum (Ach.) O. J. Rich. - Flotow 1843 (*C. pyxidata* c. *p.*), Güvenc & Öztürk 1994 (IV, V), Litterski 1997 (I, III); pl/co, submo, mo; so.

Cladonia pyxidata (L.) Hoffm. - Krempelhuber 1865 (IV, V), Güvenc & Öztürk 1994 (V, *C. chlorophaea*, *C. pyxidata*), Aptroot 1996 (III); pl/co, [mo]; Pi, so.

Cladonia ramulosa (With.) J. R. Laundon - Litterski & Mayrhofer 1998 (III); mo; so.

Cladonia rangiformis Hoffm. - Krempelhuber 1865 (IV), Güvenc & Öztürk 1994 (IV, V), Litterski 1997 (III); pl/co, submo, mo; so.

Cladonia squamosa Hoffm. - Litterski 1997 (III); mo; so.

Clauzadea immersa (Hoffm.) Hafellner & Bellem. - Litterski & Mayrhofer 1998 (I); pl/co; ca.

Clauzadea metzleri (Körb.) Clauzade & Cl. Roux - Aptroot 1996 (II), Litterski 1997 (I); pl/co; li, ro.

Collema auriforme (With.) Coppins & J. R. Laundon - Litterski 1997 (III), Litterski & Mayrhofer 1998 (III); submo, salp; mos, si.

Collema crispum (Huds.) Weber - Flotow 1843, Güvenc & Öztürk 1994 (V), Aptroot 1996 (II), Litterski 1997 (III), Litterski & Mayrhofer 1998 (III); pl/co, mo; ca, ro, si, so.

Collema cristatum (L.) Weber - Krempelhuber 1865 (IV, V), Degelius 1954 (II), Güvenc & Öztürk 1994 (V), Aptroot 1996 (II), Litterski 1997 (III), Litterski & Mayrhofer 1998 (I, III); pl/co, submo; ca, mos, ro, si, so.

Collema limosum (Ach.) Ach. - Aptroot 1996 (II);

[pl/co]; so.

Collema occultatum Bagl. - Litterski & Mayrhofer 1998 (III); submo; Al.

Collema ryssoleum (Tuck.) A. Schneid. - Litterski & Mayrhofer 1998 (I); pl/co; sa.

Collema subflaccidum Degel. - Litterski 1997 (III); submo, mo; Cd, Ce, Cu.

Collema subnigrescens Degel. - Litterski 1997 (III); submo, mo; Ac, Cu, Qu.

Collema tenax (Sw.) Ach. - Aptroot 1996 (II, III), Litterski 1997 (I, III); pl/co, submo; so.

Cyphelium tigillare (Ach.) Ach. - Litterski 1997 (III); salp; Pi.

****Dactylospora attendenda*** (Nyl.) Arnold - Litterski & Mayrhofer 1998 (III); salp; wo, on *Lecanora* sp.

Dendriscocaulon umhausense (Auersw.) Degel. - Litterski & Mayrhofer 1998 (III); mo; Cd, Qu.

Degelia plumbea (Lightf.) P. M. Jørg. & P. James - Litterski 1997 (III); mo; Cd, Qu.

Dermatocarpon miniatum (L.) W. Mann - Krempelhuber 1865 (III, *Endocarpon m.*), Litterski 1997 (III); mo, [hmo]; si.

Dermatocarpon nodulosum (Kremp.) Zahlbr. - Krempelhuber 1865 (III, *Endocarpon n.*), typus in M, teste: O. Breuß; [hmo]; ro.

Dimerella tavaresiana Vězda - Litterski & Mayrhofer 1998 (I); pl/co; Pi.

Diploicia canescens (Dicks.) A. Massal. - Güvenc & Öztürk 1995 (V), Litterski 1997 (I), Litterski & Mayrhofer 1998 (I); pl/co; ca, Ce, li, Ol, Pi, Pr, sa.

Diploschistes actinostomus (Pers. ex Ach.) Zahlbr. - Litterski & Mayrhofer 1998 (I); pl/co; ca.

Diploschistes candidissimus (Kremp.) Zahlbr. - Krempelhuber 1865 (V, *Limboria candidissima*), Lettau 1932 (*D. calcarius*), Lumbsch 1989, Litterski & Mayrhofer 1998 (I); pl/co; ca.

Diploschistes diacapsis (Ach.) Lumbsch - Litterski 1997 (III); submo; so.

Diploschistes gypsaceus (Ach.) Zahlbr. - Krempelhuber 1865 (V, *Urceolaria scruposa* var. *gypsacea*, var. *cretacea*), Aptroot 1996 (II); [pl/co]; so.

Diploschistes muscorum (Scop.) R. Sant. - Flotow 1843 (*Urceolaria villarsii* var. *macrior*), Krempelhuber 1865 (V, *Urceolaria scruposa* var. *bryophila*, var. *arenaria*), Lumbsch 1989, Litterski 1997 (III); submo; so.

Diploschistes ocellatus (Vill.) Norman - Flotow 1843 (*Urceolaria villarsii*), Krempelhuber 1865 (IV, *Urceolaria ocellata*), Lumbsch 1989, Litterski & Mayrhofer 1998 (III); pl/co; sa.

Diploschistes scruposus (Vill.) Norman - Güvenc & Öztürk 1995 (IV, V); pl/co; ca.

Diplotomma alboatrum (Hoffm.) Flot. - Krempelhuber 1865 (IV, V), Güvenc & Öztürk 1995 (IV, V, *D. alboatrum*, *D. epipolium*), Litterski 1997 (I, II, III, *D. alboatrum*, *D. epipolium*), Litterski & Mayrhofer 1998 (III); pl/co, mo; ca, Ce, li, Ol, ca, cone (Pi).

Diplotomma venustum (Körb.) Körb. - Güvenc & Öztürk 1995 (V, *Buellia venusta*); pl/co; ca.

Dirina ceratoniae (Ach.) Fr. - Tehler 1983, Litterski 1997 (I); pl/co; Ce.

Dirina cretacea (Zahlbr.) Tehler - Tehler 1983 (I, IV), Roux 1991 (map 3); [pl/co]; ca.

Dirina massiliensis Durieu & Mont. *f.* ***massiliensis*** - Krempelhuber 1865 (IV, *D. repanda*), Tehler 1983, Roux 1991 (map 2), Litterski & Mayrhofer 1998 (I); pl/co; ca, sa.

Dirina massiliensis Durieu & Mont. f. ***sorediata*** (Müll. Arg.) Tehler - Tehler 1983, Roux 1991 (map 2), Follmann 1993 (*D. stenhammari*, map 7), Litterski & Mayrhofer 1998(I); pl/co; ca, sa.

Epiphloea terrena (Nyl.) Trevis. - Aptroot 1996 (III); [mo]; so.

Evernia prunastri (L.) Ach. - Krempelhuber 1865 (III), Güvenc & Öztürk 1994 (V), Aptroot 1996 (III), Litterski 1997 (III); submo, mo, [hmo]; Cd, Pi, Qu.

Fulgensia bracteata (Hoffm.) Räsänen - Krempelhuber 1865 (IV, *Gyalolechia b.*); pl/co; -.

Fulgensia fulgens (Sw.) Elenkin - Krempelhuber 1865 (V, *Psoroma f.*), Güvenc & Öztürk 1995 (IV, V), Aptroot 1996 (II), Litterski 1997 (III); pl/co, submo; ca, so.

Fulgensia fulgida (Nyl.) Szatala - Litterski 1997 (I, III); pl/co, submo; so.

Fulgensia subbracteata (Nyl.) Poelt - Vězda 1988a (IV, No. 2191), Aptroot 1996 (II), Litterski & Mayrhofer 1998 (I, IV); pl/co; ro, so.

Fuscopannaria olivacea (P. M. Jørg.) P. M. Jørg. - Litterski 1997 (III, *Pannaria o.*); mo; Cd, Qu.

Fuscopannaria saubinetii (MONT.) P. M. Jørg. - Litterski & Mayrhofer 1998 (III); submo; Qu.

Gyalecta jenensis (Batsch) Zahlbr. - Litterski 1997 (III); mo; si.

Haematomma nemetzii J. Steiner - Litterski & Mayrhofer 1998 (I); pl/co; sa.

Heterodermia speciosa (Wulfen) Trevis. - Øvstedal 1987 (III); salp; Pi.

Hymenelia prevostii (Duby) Kremp. – Aptroot 1996 (II); [pl/co]; ro.

Hypocenomyce scalaris (Lilj.) M. Choisy - Krempelhuber 1865 (III, *Psora ostreata*), Litterski 1997 (III); [hmo], salp; Pi.

Hypogymnia farinacea Zopf - Litterski 1997 (III); salp; Pi.

Hypogymnia tubulosa (Schaer.) Hav. - Krempelhuber 1865 (III, *Parmelia ceratophylla* var. *t.*), Øvstedal 1987 (III), Litterski 1997 (III); mo, salp; Pi.

Immersaria athroocarpa (Ach.) Rambold & Pietschm. - Krempelhuber 1865 (III, *Lecidea conformis*); [mo]; si.

****Kirschsteiniothelia aethiops*** (Berk. & M. A. Curtis) D. Hawksw. - Aptroot 1996 (III); mo; -.

Lasallia pustulata (L.) Mérat - Litterski & Mayrhofer 1998 (I); pl/co;sa.

Lecania cyrtella (Ach.) Th. Fr. - Litterski & Mayrhofer 1998 (I); pl/co; br.

Lecania inundata (Hepp ex Körb.) M. Mayrhofer - Litterski 1997 (I); pl/co; sa.

Lecania spadicea (Flot.) Zahlbr. -Aptroot 1996 (II), Litterski & Mayrhofer 1998 (I); pl/co; ca, ro.

Lecania sylvestris (Arnold) Arnold - Aptroot 1996 (II); [pl/co]; ro.

Lecania turicensis (Hepp) Müll. Arg. - Litterski & Mayrhofer 1998 (I); pl/co; ca, sa.

Lecanographa grumulosa (Dufour) Egea & Torrente - Krempelhuber 1865 (V, *Lecanactis g.*), Litterski & Mayrhofer 1998 (I); pl/co; ca.

Lecanographa lyncea (Sm.) Egea & Torrente - Litterski & Mayrhofer 1998 (I); pl/co; Ce, Pi.

Lecanora achariana A. L. Sm. - Aptroot 1996 (II); [pl/co]; ro.

Lecanora allophana Nyl. - Krempelhuber 1865 (III, *Lecanora subfusca* var. *distans*), Güvenc & Öztürk 1995 (IV, V); pl/co; Cr, Cu.

Lecanora argentata (Ach.) Malme - Aptroot 1996 (III), Litterski 1997 (I, III); mo; Ac, Ce, Pi.

Lecanora bolcana (Pollini) Poelt - Krempelhuber 1865 (?, III, *Placodium saxicolum* var. *diffractum*), Litterski 1997 (III), Litterski & Mayrhofer 1998 (I, III); pl/co, mo; sa, si.

Lecanora campestris (Schaer.) Hue var. ***campestris*** - Litterski & Mayrhofer 1998 (I); pl/co; ca.

Lecanora campestris (Schaer.) Hue var. ***alba*** de Lesd. - Vězda 1988a (IV, No. 2188); pl/co; ca.

Lecanora chlarotera Nyl. - Güvenc & Öztürk 1995 (IV, V, *L. chlarona, L. chlarotera*), Kondratyuk & Poelt 1997 (III); pl/co, mo; Ce, Cu, Ol, Pi, Ps, Qu.

Lecanora dispersa (L.) Sommerf. - Aptroot 1996 (III), Litterski 1997 (II); pl/co, [mo]; li, ro.

Lecanora expallens Ach. - Aptroot 1996 (III); [mo]; Pi.

Lecanora hagenii (Ach.) Ach. - Güvenc & Öztürk 1995 (V), Aptroot 1996 (III); pl/co, [mo]; Ps, Vi.

Lecanora horiza (Ach.) Linds. - Güvenc & Öztürk 1995 (IV, *L. sienae*), Litterski 1997 (I, III); pl/co, mo, salp; Ci, Ol, Pi, Qu.

Lecanora intumescens (Rebent.) Rabenh. - Aptroot 1996 (III); [mo]; Qu.

Lecanora marginata (Schaer.) Hertel & Rambold - Krempelhuber 1865 (IV, *Lecidea elata*); [pl/co]; -.

Lecanora meridionalis H. Magn. - Litterski & Mayrhofer 1998 (I); pl/co; Ce, Cs.

Lecanora muralis (Schreb.) Rabenh. - Krempelhuber 1865 (III, *Placodium saxicolum*), Güvenc & Öztürk 1995 (V), Litterski 1997 (II, III); pl/co, mo, salp; li, si.

Lecanora piniperda Körb. - Vězda 1988a (III, No. 2189), Aptroot 1996 (III); [mo], salp; Pi.

Lecanora polytropa (Hoffm.) Rabenh. - Aptroot 1996 (III); [mo]; ro.

Lecanora pruinosa Chaub. - Güvenc & Öztürk 1995 (V); pl/co; ro.

Lecanora rupicola (L.) Zahlbr. - Litterski 1997 (III), Litterski & Mayrhofer 1998 (III); submo, mo; si.

Lecanora saligna (Schrad.) Zahlbr. var. ***sarcopsis*** Ach. - Litterski & Mayrhofer 1998 (III); salp; Pi.

Lecanora subintricata (Nyl.) Th. Fr. - Litterski 1997 (III); salp; Pi.

Lecanora sulphurea (Hoffm.) Ach. - Litterski 1997 (III), Litterski & Mayrhofer 1998 (I); pl/co, mo; sa, si.

Lecanora symmicta (Ach.) Ach. - Litterski & Mayrhofer 1998 (I); pl/co; Cs.

Lecanora umbrina (Ach.) A. Massal. - Litterski 1997 (III); mo; Pi.

Lecanora varia (Hoffm.) Ach. - Krempelhuber 1865 (III), Aptroot 1996 (III), Litterski 1997 (III); mo; Pi.

Lecidea atrobrunnea (Lam. & DC.) Schaer. - Krempelhuber 1865 (III); [hmo]; -.

Lecidea fuscoatra (L.) Ach. - Krempelhuber 1865 (?, *L. fumosa*), Aptroot 1996 (III), Litterski 1997 (III); submo, mo; ro, si.

Lecidea hypopta Ach. - Øvstedal 1987 (III, cf.), Aptroot 1996 (III); [mo], salp (cf.); Pi.

Lecidea lapicida (Ach.) Ach. var. ***pantherina*** Ach.

[pl/co]; so.

Collema occultatum Bagl. - Litterski & Mayrhofer 1998 (III); submo; Al.

Collema ryssoleum (Tuck.) A. Schneid. - Litterski & Mayrhofer 1998 (I); pl/co; sa.

Collema subflaccidum Degel. - Litterski 1997 (III); submo, mo; Cd, Ce, Cu.

Collema subnigrescens Degel. - Litterski 1997 (III); submo, mo; Ac, Cu, Qu.

Collema tenax (Sw.) Ach. - Aptroot 1996 (II, III), Litterski 1997 (I, III); pl/co, submo; so.

Cyphelium tigillare (Ach.) Ach. - Litterski 1997 (III); salp; Pi.

Dactylospora attendenda (Nyl.) Arnold - Litterski & Mayrhofer 1998 (III); salp; wo, on *Lecanora* sp.

Dendriscocaulon umhausense (Auersw.) Degel. - Litterski & Mayrhofer 1998 (III); mo; Cd, Qu.

Degelia plumbea (Lightf.) P. M. Jørg. & P. James - Litterski 1997 (III); mo; Cd, Qu.

Dermatocarpon miniatum (L.) W. Mann - Krempelhuber 1865 (III, *Endocarpon m.*), Litterski 1997 (III); mo, [hmo]; si.

Dermatocarpon nodulosum (Kremp.) Zahlbr. - Krempelhuber 1865 (III, *Endocarpon n.*), typus in M, teste: O. Breuß; [hmo]; ro.

Dimerella tavaresiana Vězda - Litterski & Mayrhofer 1998 (I); pl/co; Pi.

Diploicia canescens (Dicks.) A. Massal. - Güvenc & Öztürk 1995 (V), Litterski 1997 (I), Litterski & Mayrhofer 1998 (I); pl/co; ca, Ce, li, Ol, Pi, Pr, sa.

Diploschistes actinostomus (Pers. ex Ach.) Zahlbr. - Litterski & Mayrhofer 1998 (I); pl/co; ca.

Diploschistes candidissimus (Kremp.) Zahlbr. - Krempelhuber 1865 (V, *Limboria candidissima*), Lettau 1932 (*D. calcarius*), Lumbsch 1989, Litterski & Mayrhofer 1998 (I); pl/co; ca.

Diploschistes diacapsis (Ach.) Lumbsch - Litterski 1997 (III); submo; so.

Diploschistes gypsaceus (Ach.) Zahlbr. - Krempelhuber 1865 (V, *Urceolaria scruposa* var. *gypsacea*, var. *cretacea*), Aptroot 1996 (II); [pl/co]; so.

Diploschistes muscorum (Scop.) R. Sant. - Flotow 1843 (*Urceolaria villarsii* var. *macrior*), Krempelhuber 1865 (V, *Urceolaria scruposa* var. *bryophila*, var. *arenaria*), Lumbsch 1989, Litterski 1997 (III); submo; so.

Diploschistes ocellatus (Vill.) Norman - Flotow 1843 (*Urceolaria villarsii*), Krempelhuber 1865 (IV, *Urceolaria ocellata*), Lumbsch 1989, Litterski & Mayrhofer 1998 (III); pl/co; sa.

Diploschistes scruposus (Vill.) Norman - Güvenc & Öztürk 1995 (IV, V); pl/co; ca.

Diplotomma alboatrum (Hoffm.) Flot. - Krempelhuber 1865 (IV, V), Güvenc & Öztürk 1995 (IV, V, *D. alboatrum*, *D. epipolium*), Litterski 1997 (I, II, III, *D. alboatrum*, *D. epipolium*), Litterski & Mayrhofer 1998 (III); pl/co, mo; ca, Ce, li, Ol, ca, cone (Pi).

Diplotomma venustum (Körb.) Körb. - Güvenc & Öztürk 1995 (V, *Buellia venusta*); pl/co; ca.

Dirina ceratoniae (Ach.) Fr. - Tehler 1983, Litterski 1997 (I); pl/co; Ce.

Dirina cretacea (Zahlbr.) Tehler - Tehler 1983 (I, IV), Roux 1991 (map 3); [pl/co]; ca.

Dirina massiliensis Durieu & Mont. *f.* ***massiliensis*** - Krempelhuber 1865 (IV, *D. repanda*), Tehler 1983, Roux 1991 (map 2), Litterski & Mayrhofer 1998 (I); pl/co; ca, sa.

Dirina massiliensis Durieu & Mont. f. ***sorediata*** (Müll. Arg.) Tehler - Tehler 1983, Roux 1991 (map 2), Follmann 1993 (*D. stenhammari*, map 7), Litterski & Mayrhofer 1998(I); pl/co; ca, sa.

Epiphloea terrena (Nyl.) Trevis. - Aptroot 1996 (III); [mo]; so.

Evernia prunastri (L.) Ach. - Krempelhuber 1865 (III), Güvenc & Öztürk 1994 (V), Aptroot 1996 (III), Litterski 1997 (III); submo, mo, [hmo]; Cd, Pi, Qu.

Fulgensia bracteata (Hoffm.) Räsänen - Krempelhuber 1865 (IV, *Gyalolechia b.*); pl/co; -.

Fulgensia fulgens (Sw.) Elenkin - Krempelhuber 1865 (V, *Psoroma f.*), Güvenc & Öztürk 1995 (IV, V), Aptroot 1996 (II), Litterski 1997 (III); pl/co, submo; ca, so.

Fulgensia fulgida (Nyl.) Szatala - Litterski 1997 (I, III); pl/co, submo; so.

Fulgensia subbracteata (Nyl.) Poelt - Vězda 1988a (IV, No. 2191), Aptroot 1996 (II), Litterski & Mayrhofer 1998 (I, IV); pl/co; ro, so.

Fuscopannaria olivacea (P. M. Jørg.) P. M. Jørg. - Litterski 1997 (III, *Pannaria o.*); mo; Cd, Qu.

Fuscopannaria saubinetii (MONT.) P. M. Jørg. - Litterski & Mayrhofer 1998 (III); submo; Qu.

Gyalecta jenensis (Batsch) Zahlbr. - Litterski 1997 (III); mo; si.

Haematomma nemetzii J. Steiner - Litterski & Mayrhofer 1998 (I); pl/co; sa.

Heterodermia speciosa (Wulfen) Trevis. - Øvstedal 1987 (III); salp; Pi.

Hymenelia prevostii (Duby) Kremp. – Aptroot 1996 (II); [pl/co]; ro.

Hypocenomyce scalaris (Lilj.) M. Choisy - Krempelhuber 1865 (III, *Psora ostreata*), Litterski 1997 (III); [hmo], salp; Pi.

Hypogymnia farinacea Zopf - Litterski 1997 (III); salp; Pi.

Hypogymnia tubulosa (Schaer.) Hav. - Krempelhuber 1865 (III, *Parmelia ceratophylla* var. *t.*), Øvstedal 1987 (III), Litterski 1997 (III); mo, salp; Pi.

Immersaria athroocarpa (Ach.) Rambold & Pietschm. - Krempelhuber 1865 (III, *Lecidea conformis*); [mo]; si.

****Kirschsteiniothelia aethiops*** (Berk. & M. A. Curtis) D. Hawksw. - Aptroot 1996 (III); mo; -.

Lasallia pustulata (L.) Mérat - Litterski & Mayrhofer 1998 (I); pl/co;sa.

Lecania cyrtella (Ach.) Th. Fr. - Litterski & Mayrhofer 1998 (I); pl/co; br.

Lecania inundata (Hepp ex Körb.) M. Mayrhofer - Litterski 1997 (I); pl/co; sa.

Lecania spadicea (Flot.) Zahlbr. -Aptroot 1996 (II), Litterski & Mayrhofer 1998 (I); pl/co; ca, ro.

Lecania sylvestris (Arnold) Arnold - Aptroot 1996 (II); [pl/co]; ro.

Lecania turicensis (Hepp) Müll. Arg. - Litterski & Mayrhofer 1998 (I); pl/co; ca, sa.

Lecanographa grumulosa (Dufour) Egea & Torrente - Krempelhuber 1865 (V, *Lecanactis g.*), Litterski & Mayrhofer 1998 (I); pl/co; ca.

Lecanographa lyncea (Sm.) Egea & Torrente - Litterski & Mayrhofer 1998 (I); pl/co; Ce, Pi.

Lecanora achariana A. L. Sm. - Aptroot 1996 (II); [pl/co]; ro.

Lecanora allophana Nyl. - Krempelhuber 1865 (III, *Lecanora subfusca* var. *distans*), Güvenc & Öztürk 1995 (IV, V); pl/co; Cr, Cu.

Lecanora argentata (Ach.) Malme - Aptroot 1996 (III), Litterski 1997 (I, III); mo; Ac, Ce, Pi.

Lecanora bolcana (Pollini) Poelt - Krempelhuber 1865 (?, III, *Placodium saxicolum* var. *diffractum*), Litterski 1997 (III), Litterski & Mayrhofer 1998 (I, III); pl/co, mo; sa, si.

Lecanora campestris (Schaer.) Hue var. ***campestris*** - Litterski & Mayrhofer 1998 (I); pl/co; ca.

Lecanora campestris (Schaer.) Hue var. ***alba*** de Lesd. - Vězda 1988a (IV, No. 2188); pl/co; ca.

Lecanora chlarotera Nyl. - Güvenc & Öztürk 1995 (IV, V, *L. chlarona*, *L. chlarotera*), Kondratyuk & Poelt 1997 (III); pl/co, mo; Ce, Cu, Ol, Pi, Ps, Qu.

Lecanora dispersa (L.) Sommerf. - Aptroot 1996 (III), Litterski 1997 (II); pl/co, [mo]; li, ro.

Lecanora expallens Ach. - Aptroot 1996 (III); [mo]; Pi.

Lecanora hagenii (Ach.) Ach. - Güvenc & Öztürk 1995 (V), Aptroot 1996 (III); pl/co, [mo]; Ps, Vi.

Lecanora horiza (Ach.) Linds. - Güvenc & Öztürk 1995 (IV, *L. sienae*), Litterski 1997 (I, III); pl/co, mo, salp; Ci, Ol, Pi, Qu.

Lecanora intumescens (Rebent.) Rabenh. - Aptroot 1996 (III); [mo]; Qu.

Lecanora marginata (Schaer.) Hertel & Rambold - Krempelhuber 1865 (IV, *Lecidea elata*); [pl/co]; -.

Lecanora meridionalis H. Magn. - Litterski & Mayrhofer 1998 (I); pl/co; Ce, Cs.

Lecanora muralis (Schreb.) Rabenh. - Krempelhuber 1865 (III, *Placodium saxicolum*), Güvenc & Öztürk 1995 (V), Litterski 1997 (II, III); pl/co, mo, salp; li, si.

Lecanora piniperda Körb. - Vězda 1988a (III, No. 2189), Aptroot 1996 (III); [mo], salp; Pi.

Lecanora polytropa (Hoffm.) Rabenh. - Aptroot 1996 (III); [mo]; ro.

Lecanora pruinosa Chaub. - Güvenc & Öztürk 1995 (V); pl/co; ro.

Lecanora rupicola (L.) Zahlbr. - Litterski 1997 (III), Litterski & Mayrhofer 1998 (III); submo, mo; si.

Lecanora saligna (Schrad.) Zahlbr. var. ***sarcopsis*** Ach. - Litterski & Mayrhofer 1998 (III); salp; Pi.

Lecanora subintricata (Nyl.) Th. Fr. - Litterski 1997 (III); salp; Pi.

Lecanora sulphurea (Hoffm.) Ach. - Litterski 1997 (III), Litterski & Mayrhofer 1998 (I); pl/co, mo; sa, si.

Lecanora symmicta (Ach.) Ach. - Litterski & Mayrhofer 1998 (I); pl/co; Cs.

Lecanora umbrina (Ach.) A. Massal. - Litterski 1997 (III); mo; Pi.

Lecanora varia (Hoffm.) Ach. - Krempelhuber 1865 (III), Aptroot 1996 (III), Litterski 1997 (III); mo; Pi.

Lecidea atrobrunnea (Lam. & DC.) Schaer. - Krempelhuber 1865 (III); [hmo]; -.

Lecidea fuscoatra (L.) Ach. - Krempelhuber 1865 (?, *L. fumosa*), Aptroot 1996 (III), Litterski 1997 (III); submo, mo; ro, si.

Lecidea hypopta Ach. - Øvstedal 1987 (III, cf.), Aptroot 1996 (III); [mo], salp (cf.); Pi.

Lecidea lapicida (Ach.) Ach. var. ***pantherina*** Ach.

- Krempelhuber 1865 (III, *L. polycarpa*); [mo, hmo]; -.

Lecidea lurida Ach. - Güvenc & Öztürk 1995 (V, *Psora l.*); submo; ca.

Lecidea sarcogynoides Körb. - Litterski & Mayrhofer 1998 (I); pl/co; sa.

Lecidella achristotera (Nyl.) Hertel & Leuckert - Güvenc & Öztürk 1995 (V); pl/co; Cr, Ps.

Lecidella asema (Nyl.) Knoph & Hertel - Güvenc & Öztürk 1995 (V); pl/co; ca.

Lecidella carpathica Körb. - Aptroot 1996 (III), Litterski 1997 (III); [mo], salp; ro, si.

Lecidella elaeochroma (Ach.) M. Choisy - Krempelhuber 1865 (III, *Lecidea enteroleuca* var. *rugulosa*), Güvenc & Öztürk 1995 (IV, V), Litterski 1997 (III), Litterski & Mayrhofer 1998 (III); pl/co, mo, [hmo], salp; Ac, Ce, Ci, Cu, Ol, Pi, Ps, Qu.

Lecidella euphorea (Flörke) Hertel – Krempelhuber 1865 (V, *Lecidea sabuletorum* var. *e.*), Güvenc & Öztürk 1995 (IV), Aptroot 1996 (III), Kondratyuk & Poelt 1997 (III); pl/co, mo; Ce, Pi, Qu.

Lecidella stigmatea (Ach.) Hertel & Leuckert - Aptroot 1996 (III); [mo]; ro.

Lempholemma chalazanum (Ach.) de Lesd. - Krempelhuber 1865 (III, *Physma compactum* - *Collema ch.*); [mo]; -.

Lempholemma elveloideum (Ach.) Zahlbr. - Litterski & Mayrhofer 1998 (I); pl/co; ca.

Lepraria crassissima (Hue) Lettau var. ***isidiata*** Llimona - Vězda 1988a (IV, No. 2192), Güvenc & Öztürk 1995 (V); pl/co; ca.

Lepraria incana (L.) Ach. - Litterski 1997 (III); mo; Pi.

Lepraria nivalis J. R. Laundon - Litterski 1997 (III), Litterski & Mayrhofer 1998 (I); pl/co, submo, mo; ca, si, so.

Leprocaulon microscopicum (Vill.) D. Hawksw. - Litterski 1997 (III); submo, mo; so (among si).

Leproloma diffusum J. R. Laundon - Aptroot 1996 (III); [mo]; ro.

Leptochidium albociliatum (Desm.) M. Choisy - Krempelhuber 1865 (III, *Collema a.*), Aptroot 1996 (III), Litterski 1997 (III); mo, [hmo]; mos, si, so.

Leptogium biatorinum (Nyl.) Leight. - Aptroot 1996 (II); [pl/co]; ro, so.

Leptogium corniculatum (Hoffm.) Minks - Aptroot 1996 (III); [mo]; so.

Leptogium gelatinosum (With.) J. R. Laundon - Litterski 1997 (III), Litterski & Mayrhofer 1998 (III); submo, mo; mos.

Leptogium lichenoides (L.) Zahlbr. – Krempelhuber 1865 (III, V, *L. atrocaeruleum*), Aptroot 1996 (III), Litterski 1997 (III); mo; Cd,ro, wo.

Leptogium subtile (Schrad.) Torss. - Litterski & Mayrhofer 1998 (III); submo, mo; Qu.

Leptogium teretiusculum (Wallr.) Arnold - Litterski & Mayrhofer 1998 (III); pl/co; so.

Leptogium turgidum (Ach.) Cromb. – Krempelhuber 1865 (I, *Collema t.*); [pl/co]; -.

Letharia vulpina (L.) Hue - Krempelhuber 1865 (III, *Evernia v.*), Petrak *et al.* 1941, Schade 1954 (III), Gams 1955, Hafellner 1987, Øvstedal 1987 (III), Vězda 1988b (III, No. 2250), Litterski 1997 (III); [hmo], salp; Pi.

****Lichenodiplis lecanorae*** (Vouaux) Dyko & D. Hawksw. - Aptroot 1996 (III); [mo]; on *Caloplaca cerina.*

****Lichenostigma elongata*** Nav.-Ros. & Hafellner - Navarro-Rosinés & Hafellner 1996 (IV); pl/co; on *Lobothallia radiosa.*

Lobothallia praeradiosa (Nyl.) Hafellner - Litterski 1997 (III, *Aspicilia p.*); salp; si.

Lobothallia radiosa (Hoffm.) Hafellner - Krempelhuber 1865 (II, *Placodium radiosum*), Hermann *et al.* 1973 (II, *Lecanora r.*), Litterski & Mayrhofer 1998 (III), Navarro-Rosinés & Hafellner 1996 (IV); pl/co, salp; si.

Megaspora verrucosa (Ach.) Hafellner & V. Wirth var. ***mutabilis*** Nimis & Cl. Roux - Øvstedal 1987 (III, *Aspicilia m.*), Litterski 1997 (III); salp; Jn, Pi.

Melanelia elegantula (Zahlbr.) Essl. - Litterski 1997 (III); salp; Pi.

Melanelia exasperata (De Not.) Essl. - Krempelhuber 1865 (III, *P. aspera*), Esslinger 1977 (*Parmelia e.*, fig. 15), Litterski 1997 (III); mo, [hmo], salp; Pi, Qu.

Melanelia exasperatula (Nyl.) Essl. - Øvstedal 1987 (III); salp; Pi.

Melanelia glabra (Schaer.) Essl. - Litterski 1997 (III); mo; Ce, Cu, Qu.

Melanelia glabratula (Lamy) Essl. - Litterski 1997 (III); mo; Pi.

Melanelia laciniatula (H. Olivier) Essl. - Litterski 1997 (III); mo; Cd, Pi, Qu.

Micarea erratica (Körb.) Hertel, Rambold & Pietschm. - Aptroot 1996 (III); [mo]; ro.

Micarea misella (Nyl.) Hedl. - Litterski & Mayrhofer 1998 (III); pl/co; wo/Pi.

Micarea prasina Fr. - Litterski 1997 (III); mo; cone (Pi).

Moelleropsis nebulosa (Hoffm.) Gyeln. - Litterski & Mayrhofer 1998 (III); submo; so.

Mycobilimbia hypnorum (Lib.) Kalb & Hafellner - Litterski & Mayrhofer 1998 (III); pl/co; mo/so.

Mycobilimbia sphaeroides (Dicks.) ined. - Flotow 1843 (*Lecidea sabuletorum, pilularis*); -; br.

Naetrocymbe punctiformis A. Massal. - Aptroot 1996 (III, *Arthopyrenia p.*), Litterski & Mayrhofer 1998 (I, *Arthopyrenia p.*); pl/co, [mo]; Ne, Qu.

Neofuscelia luteonotata (J. Steiner) Essl. - Vezda 1988a (IV, No. 2195, *Parmelia l.*); pl/co; si.

Neofuscelia pulla (Ach.) Essl. - Güvenc & Öztürk 1994 (V, *Parmelia p.*), Aptroot 1996 (III), Litterski 1997 (III), Litterski & Mayrhofer 1998 (I, III); pl/co, submo, mo; ro, si.

Nephroma laevigatum Ach. - Litterski 1997 (III); mo; Cd, Qu.

Ochrolechia balcanica Verseghy - Litterski 1997 (III); mo; Qu.

Ochrolechia pallescens (L.) A. Massal. - Litterski 1997 (III); mo; Cd, Pi.

Ochrolechia parella (L.) A. Massal. - Litterski 1997 (III); submo; si.

Opegrapha calcarea Turner ex Sm. & Sowerby - Litterski & Mayrhofer 1998 (I); pl/co; ca.

Opegrapha durieui Mont. - Roux & Egea 1992 (IV); pl/co; ca.

****Opegrapha physciaria*** (Nyl.) D. Hawksw. & Coppins - Litterski & Mayrhofer 1998 (I); pl/co; on *Xanthoria parietina* (thallus).

Opegrapha rupestris Pers. - Krempelhuber 1865 (III); [submo]; sa.

Opegrapha varia Pers. - Litterski 1997 (I), Litterski & Mayrhofer 1998 (*O. v.* var. *herbarum*, var. *varia*, I, III); pl/co, submo; Ce, Jn, Qu.

Opegrapha variaeformis Anzi - Roux & Egea 1992 (IV); pl/co; ca.

Parmelia saxatilis (L.) Ach. - Krempelhuber 1865 (III), Litterski 1997 (III); mo, [hmo]; Pi, si.

Parmelia submontana Nadv. ex Hale - Litterski 1997 (III); mo; Cd, Pi.

Parmelina carporrhizans (Taylor) Poelt & Vězda - Krempelhuber 1865 (III, *Parmelia c.*); [mo]; -

Parmelina pastillifera (Harm.) Hale - Litterski 1997 (III); mo; si.

Parmelina quercina (Willd.) Hale - Aptroot 1996 (III); [mo]; Qu.

Parmelina tiliacea (Hoffm.) Hale - Krempelhuber 1865 (?, III, *Parmelia quercifolia* a *t.*), Güvenc & Öztürk 1994 (V, *Parmelia t.*), Litterski 1997 (III); submo, mo; Cd, Ce, Pi.

Parmeliella triptophylla (Ach.) Müll. Arg. - Flotow 1843 (*Biatora t.* var. *corallinoides*); -; -.

Parmeliopsis ambigua (Wulfen) Nyl. - Litterski 1997 (III); salp; Pi.

Peltigera canina (L.) Willd. - Litterski 1997 (III); mo; so.

Peltigera neckeri Müll. Arg. - Krempelhuber 1865 (I, as *P. polydactyla*, WU, teste), Litterski 1997 (III); [pl/co], mo; so.

Peltigera rufescens (Weiss) Humb. - Aptroot 1996 (III), Litterski 1997 (III); mo; so.

Pertusaria albescens (Huds.) M. Choisy & Werner - Güvenc & Öztürk 1995 (V), Litterski 1997 (III); pl/co, submo, mo; ca, Cd, Cu, Pi, Qu, mos, si.

Pertusaria amara (Ach.) Nyl. - Güvenc & Öztürk 1995 (V); pl/co; Cu, so.

Pertusaria coccodes (Ach.) Nyl. - Litterski 1997 (III); mo; Cd, Pi.

Pertusaria flavicans Lamy - Litterski & Mayrhofer 1998 (I); pl/co; sa.

Pertusaria hemisphaerica (Flörke) Erichsen - Litterski & Mayrhofer 1998 (III); mo; Cd, Qu.

Pertusaria hymenea (Ach.) Schaer. - Litterski 1997 (III); mo; Ce, Qu.

Pertusaria leucostoma (Bernh.) A. Massal. - Güvenc & Öztürk 1995 (V); pl/co; Ps.

Pertusaria maximiliana Klem. - Litterski & Mayrhofer 1998 (I); pl/co; Jn.

Pertusaria pertusa auct. - Güvenc & Öztürk 1995 (V), Litterski 1997 (III); submo, mo; Cd, Ce, Cu, Qu.

Pertusaria rupicola (Fr.) Harm. var. ***coralloidea*** (Anzi) Croz. - Litterski & Mayrhofer 1998 (III); mo; si.

****Phacopsis vulpina*** Tul. - Hafellner 1987, Vězda 1988b (III, No. 2250); salp; on thallus of *Letharia vulpina.*

Phaeophyscia orbicularis (Neck.) Moberg - Krempelhuber 1865 (III, *Anaptychia obscura* var. *o.*), Kondratyuk & Poelt 1997 (III); mo; Qu.

Phaeophyscia poeltii (Frey) Nimis - Aptroot 1996 (III); [mo]; Qu.

Physcia adscendens (Fr.) H. Olivier - Krempelhuber 1865 (III, *Anaptychia stellaris* v. *hispida*), Güvenc & Öztürk 1994 (IV, V), Aptroot 1996 (III), Litterski 1997 (III), Litterski & Mayrhofer 1998 (III); pl/co, submo, mo, salp; Ce, Cr, Cu, Ol, Pi, Ps, Qu, ro.

Physcia aipolia (Ehrh. ex. Humb.) Fürnr. - Krempelhuber 1865 (III, *Anaptychia stellaris* a. *a.*), Güvenc & Öztürk 1994 (V), Øvstedal 1987 (III), Aptroot 1996 (III), Kondratyuk & Poelt 1997 (III); pl/co, mo, [hmo], salp; Ce, Pi, Qu.

Physcia biziana (A. Massal.) Zahlbr. - Aptroot 1996 (III), Litterski 1997 (III), Litterski & Mayrhofer 1998 (I); pl/co, [mo], salp; ca, Jn, Pi

Physcia caesia (Hoffm.) Fürnr. - Litterski 1997 (I, III); pl/co, mo; li, si.

Physcia dimidiata (Arnold) Nyl. - Litterski & Mayrhofer 1998 (III); pl/co; si.

Physcia dubia (Hoffm.) Lettau - Krempelhuber 1865 (III, *Anaptychia pulchella* var. *d.*); [mo, hmo]; ro.

Physcia scopulorum (Lambinon & Vězda) Poelt & Nimis - Litterski & Mayrhofer 1998 (I); pl/co; ca.

Physcia semipinnata (J. F. Gmel.) Moberg - Güvenc & Öztürk 1994 (IV, V), Aptroot 1996 (III), Kondratyuk & Poelt 1997 (III), Litterski & Mayrhofer 1998 (III); pl/co, submo, mo, salp; br, Ce, Cd, Cr, Cu, Ol, Pi, Ps, Qu.

Physcia stellaris (L.) Nyl. - Krempelhuber 1865 (III, *Anaptychia st.* ß. *ambigua*), Aptroot 1996 (III), Litterski 1997 (III), Litterski & Mayrhofer 1998 (III); pl/co, mo, [hmo], salp; mos, si, Cd, Ol, Qu.

Physcia tenella (Scop.) DC. - Güvenc & Öztürk 1994 (IV, V), Aptroot 1996 (III); pl/co, submo, mo; Ce, Cr, Pi, Ps.

Physconia americana Essl. - GZU (III) (Troodos, Cedar Valley, on *Cedrus*, ca. 1000 m, leg. H. Mayrhofer 1987, det./rev. Th. Esslinger 1997); mo; Cd.

Physconia distorta (With.) J. R. Laundon - Krempelhuber 1865 (III, *Anaptychia pulverulenta* var. *muscicola*), Güvenc & Öztürk 1994 (V), Aptroot 1996 (III), Litterski 1997 (III), Kondratyuk & Poelt 1997 (III); submo, mo, hmo; Cd, Ce, Cu, Pi, Qu.

Physconia enteroxantha (Nyl.) Poelt - Litterski 1997 (III), Kondratyuk & Poelt 1997 (III); mo; Qu, si.

Physconia grisea (Lam.) Poelt - Krempelhuber 1865 (III, *Anaptychia pulverulenta* var. *g.*), Øvstedal 1987 (III); salp; Pi.

Physconia muscigena (Ach.) Poelt - Krempelhuber 1865 (III, *Anaptychia pulverulenta* var. *angustata*); [mo, hmo]; Jn.

Physconia perisidiosa (Erichsen) Moberg - Litterski 1997 (III); mo; Qu.

Physconia subpulverulenta (Szatala) Poelt - Litterski 1997 (III); mo; Qu.

Physconia venusta (Ach.) Poelt - Krempelhuber 1865 (III, *Anaptychia pulverulenta* var. *v.*); [mo]; -.

Placidium adami-borosi Szatala - Breuss 1990 (III, *Catapyrenium a.*); [hmo]; -.

Placidium michelii A. Massal. - Aptroot 1996 (II, *Catapyrenium m.*); [pl/co]; ro.

Placidium rufescens (Ach.) A. Massal. - Krempelhuber 1865 (III); [hmo]; -.

Placidium semaforonense (Breuss) Breuss - Breuss 1990 (I, *Catapyrenium s.*), Aptroot 1996 (II, *Catapyrenium s.*); [pl/co]; so.

Placidium tenellum (Breuss) Breuss - Breuss 1990 (V, *Catapyrenium t.*); [pl/co]; so.

Placynthiella icmalea (Ach.) Coppins & P. James - Aptroot 1996 (III); [mo]; Pi.

Placynthium nigrum (Huds.) Gray - Litterski & Mayrhofer 1998 (I, III); pl/co; sa, si.

Platismatia glauca (L.) W. L. Culb. et C. F. Culb. - Krempelhuber 1865 (III, *Cetraria g.*), Litterski 1997 (III); mo, [hmo]; Cd, Pi, Qu.

Pleurosticta acetabulum (Neck.) Elix & Lumbsch - Güvenc & Öztürk 1994 (V, *Parmelia a.*); submo; Cu.

Porina linearis (Leight.) Zahlbr. - Litterski & Mayrhofer 1998 (I); pl/co; ca.

Porpidia melinodes (Körb.) Gowan & P. James - Aptroot 1996 (III); [mo]; ro.

Protoparmelia montagnei (Fr.) Poelt & Nimis - Krempelhuber 1865 (I, II, *Placodium m.* var. *calcarea*), Litterski & Mayrhofer 1998 (I); pl/co; sa.

Pseudevernia furfuracea (L.) Zopf - Krempelhuber 1865 (III, *Evernia f.*), Øvstedal 1987 (III), Litterski 1997 (III); mo, [hmo], salp; Pi, Qu.

Psora decipiens (Hedw.) Hoffm. - Flotow 1843 (*Biatora d.*), Krempelhuber 1865 (?), Güvenc & Öztürk 1995 (IV, V), Aptroot 1996 (II), Litterski 1997 (II, III); pl/co, submo; ca, so.

Psora testacea Hoffm. - Krempelhuber 1865 (III, *Psora t.* var. *turgida*); [mo]; -.

Pyrenula chlorospila Arnold - Litterski & Mayrhofer 1998 (I); pl/co; Ce.

Pyrrhospora quernea (Dicks.) Körb. - Litterski & Mayrhofer 1998 (I); pl/co; Cs, Jn.

Ramalina breviuscula Nyl. - Litterski & Mayrhofer 1998 (I); pl/co; sa, si.

Ramalina calicaris (L.) Fr. - Litterski 1997 (III), Litterski & Mayrhofer 1998 (I); pl/co, mo; Cd, Pr, Qu.

Ramalina canariensis J. Steiner - Güvenc & Öztürk 1994 (IV), Litterski 1997 (I), Litterski & Mayrhofer 1998 (I); pl/co; Ce, Pi, Ps, Pr.

Ramalina capitata (Ach.) Nyl. var. ***digitellata*** (Nyl.) Nimis - Litterski & Mayrhofer 1998 (I); pl/co; sa.

Ramalina farinacea (L.) Ach. – Krempelhuber

1865 (III), Güvenc & Öztürk 1994 (IV, V), Litterski 1997 (III), Litterski & Mayrhofer 1998 (I); pl/co, submo, mo, [hmo]; Pi, Pr, Qu.

Ramalina fastigiata (Pers.) Ach. - Güvenc & Öztürk 1994 (V), Litterski & Mayrhofer 1998 (III); pl/co, submo, mo; Cd, Cr, Ol, Pi, Ps, Qu.

Ramalina fraxinea (L.) Ach. - Krempelhuber 1865 (?), Güvenc & Öztürk 1994 (V); pl/co, submo; Cr, Pi, Ps.

Ramalina obtusata (Arnold) Bitter - Güvenc & Öztürk 1994 (V); pl/co; Ce, Cu, Ol, Pi, Ps.

Ramalina pollinaria (Westr.) Ach. - Krempelhuber 1865 (?); -; -.

Ramalina pusilla Le Prévost - Krempelhuber 1865 (V), Litterski & Mayrhofer 1998 (I); pl/co; Jn

Ramalina roesleri (Schaer.) Hue - Güvenc & Öztürk 1994 (V); pl/co, submo; Ce, Ps.

Ramalina subfarinacea (Cromb.) Nyl. - Güvenc & Öztürk 1994 (V); submo; Pi.

Rhizocarpon geographicum (L.) DC. - Krempelhuber 1865 (III), Aptroot 1996 (III), Litterski 1997 (III); submo, mo, hmo; ro, si.

Rhizocarpon lecanorinum Anders - Litterski 1997 (III); mo; si.

Rhizocarpon macrosporum Räsänen - Runemark 1956 (III); [mo]; -.

Rhizocarpon obscuratum (Ach.) A. Massal. - Aptroot 1996 (III); [mo]; ro.

Rhizocarpon polycarpum (Hepp) Th. Fr. - Litterski 1997 (III); submo; si.

Rhizocarpon umbilicatum (Ramond) Flagey - Aptroot 1996 (III); [mo]; ro.

Rhizocarpon viridiatrum (Wulfen) Körb. - Litterski & Mayrhofer 1998 (III); pl/co; sa.

Rhizoplaca chrysoleuca (Sm.) Zopf - Güvenc & Öztürk 1995 (V); pl/co; ca.

Rimularia insularis (Nyl.) Rambold & Hertel - Litterski & Mayrhofer 1998 (III); mo; si, on *Lecanora rupicola.*

Rinodina bischoffii (Hepp) A. Massal. - Litterski & Mayrhofer 1998 (I, IV); pl/co; ca.

Rinodina capensis Hampe - Giralt & Mayrhofer 1994 (III); mo; Cd.

Rinodina dalmatica Zahlbr. - Litterski & Mayrhofer 1998 (I); pl/co; Pi.

Rinodina dubyana (Hepp) J. Steiner - Litterski & Mayrhofer 1998 (I); pl/co; ca.

Rinodina exigua (Ach.) Gray - Güvenc & Öztürk 1995 (IV), Aptroot 1996 (III), Litterski 1997 (III); pl/co, submo, mo; Cd, Cu, Pi, Ps, Qu.

Rinodina gennarii Bagl. - Litterski & Mayrhofer 1998 (III); pl/co; sa.

Rinodina guzzinii Jatta - Litterski & Mayrhofer 1998 (III); pl/co; sa.

Rinodina llimonae Giralt & Etayo - Giralt & Mayrhofer 1995 (III); salp; Jn, Pi.

Rinodina oxydata (A. Massal.) A. Massal. - Aptroot 1996 (III); [mo]; ro.

Rinodina pyrina (Ach.) Arnold -Giralt & Mayrhofer 1995 (IV), Güvenc & Öztürk 1995 (IV), Aptroot 1996 (III), Litterski 1997 (III); pl/co, mo; Ce, Pi, Qu, Vi.

Rinodina septentrionalis Malme - Giralt & Mayrhofer 1995 (III); mo, salp; Pi, Qu.

Rinodina sophodes (Ach.) A. Massal. - Giralt & Mayrhofer 1995 (III), Aptroot 1996 (III), Litterski 1997 (III); mo, salp; Cd, Qu.

Rinodina teichophila (Nyl.) Arnold - Litterski & Mayrhofer 1998 (I); pl/co; sa.

Rinodina trachytica (A. Massal.) Bagl. & Carestia - Mayrhofer *et al.* 1992 (III); [submo]; si.

Roccella phycopsis Ach. - Güvenc & Öztürk 1994 (V), Litterski & Mayrhofer 1998 (I); pl/co; ca, Pi, sa.

Sarcogyne regularis Körb. - Aptroot 1996 (II), Litterski & Mayrhofer 1998 (III, IV); pl/co; ca, ro, si.

Schismatomma decolorans (Sm.) Clauzade & Vězda - Litterski & Mayrhofer 1998 (I); pl/co; Ce.

Solenopsora candicans (Dicks.) J. Steiner - Güvenc & Öztürk 1995 (V); submo; ca.

Solenopsora cesatii A. Massal. var. ***cesatii*** - Litterski & Mayrhofer 1998 (I); pl/co; ca.

Solenopsora cesatii A. Massal. var. ***grisea*** (Bagl.) Nimis - Güvenc & Öztürk 1995 (V, *S. bagliettoana*), Litterski & Mayrhofer 1998 (I); pl/co; ca, mo.

Solenopsora olivacea (Fr.) H. Kilias - Krempelhuber 1865 (V, *Biatorina Michelettiana*); [pl/co]; -.

Squamarina cartilaginea (With.) P. James - Flotow 1843 (*Lecanora crassa*, *Lecanora crassa* f. *macra*), Krempelhuber 1865 (IV, *Psoroma crassum* ß. *caespitosum*), Güvenc & Öztürk 1995 (IV, V), Aptroot 1996 (II), Litterski 1997 (I, III); pl/co; ca, mo, so.

Squamarina concrescens (Müll. Arg.) Poelt - Litterski 1997 (III), Litterski & Mayrhofer 1998 (I); pl/co, submo; so.

Squamarina lentigera (Weber) Poelt - Flotow 1843 (*Lecanora l.*), Krempelhuber 1865 (IV, *Psoroma lentigerum*), Güvenc & Öztürk 1995 (IV), Aptroot 1996 (II), Litterski 1997 (III), Litterski & Mayrhofer 1998 (I, III); pl/co, submo; ca, so.

Staurothele rufa (A. Massal.) Zschacke - Aptroot 1996 (II); [pl/co]; ro.

Tephromela atra (Huds.) Hafellner - Flotow 1843 (*Lecanora a.*), Krempelhuber 1865 (III, IV, *Lecanora a.*), Litterski 1997 (III), Litterski & Mayrhofer 1998 (I); pl/co, submo, mo; sa, si, Ac.

Tephromela atra (Huds.) Hafellner var. ***cypria*** (Körb.) Nimis - Koerber 1862 (*Lecanora cypria*); -; ca.

Thelopsis isiaca Stizenb. - Litterski 1997 (I); pl/co; Ce.

Toninia aromatica (Sm.) A. Massal. - Timdal 1991; -; -.

Toninia cinereovirens (Schaer.) A. Massal. - Timdal 1991; -; -.

Toninia diffracta (A. Massal.) Zahlbr. - Timdal 1991; -; -.

Toninia episema (Nyl.) Timdal - Timdal 1991; -; -.

Toninia massata (Tuck.) Herre - Timdal 1991; -; -.

Toninia plumbina (Anzi) Hafellner & Timdal - Timdal 1991; -; -.

Toninia sedifolia (Scop.) Timdal - Krempelhuber 1865 (III, *Thalloidima vesicularis*), Timdal 1991, Güvenc & Öztürk 1995 (V, *T. caeruleonigricans*), Aptroot 1996 (II), Litterski 1997 (II, III), Litterski & Mayrhofer 1998 (I); pl/co, submo; ca, so.

Toninia toepfferi (Stein) Navas - Litterski 1997 (III); submo; so.

Toninia tristis (Th. Fr.) Th. Fr. - Vězda 1988c (IV, No. 2262); pl/co; so.

Toninia tristis (Th. Fr.) Th. Fr. ssp. ***pseudotabacina*** Timdal - Timdal 1991; -; -.

Topelia heterospora (Zahlbr.) P. M. Jørg. & Vězda - Litterski & Mayrhofer 1998 (I); pl/co; ca.

Tornabea scutellifera (With.) J. R. Laundon - Güvenc & Öztürk 1994 (V, *Anaptychia intricata*), Litterski & Mayrhofer 1998 (III); submo, mo; br, Cu.

Trapelia coarctata (Sm.) M. Choisy - Aptroot 1996 (III), Litterski & Mayrhofer 1998 (III); pl/co, [mo]; ro, so.

Usnea ceratina Ach. - Krempelhuber 1865 (III); [mo, hmo]; -.

Usnea scabrata Nyl. - Litterski 1997 (III); mo; Qu.

Usnea subfloridana Stirt. - Litterski 1997 (III); mo; Pi.

Verrucaria calciseda DC. - Krempelhuber 1865 (II), Aptroot 1996 (II), Litterski 1997 (I, II); pl/co; ca, li, ro.

Verrucaria fuscella (Turner) Winch - Krempelhuber 1865 (IV); [pl/co]; -.

Verrucaria geophila Zahlbr. - Litterski & Mayrhofer 1998 (I); pl/co; so.

Verrucaria lecideoides (A. Massal.) Trevis. - Krempelhuber 1865 (IV); [pl/co]; -.

Verrucaria macrostoma Dufour - Aptroot 1996 (II); [pl/co]; ro.

Verrucaria muralis Ach. - Aptroot 1996 (II, III), Litterski 1997 (I, III); pl/co, submo, mo; ca, li, ro, sa, si.

Verrucaria nigrescens Pers. - Krempelhuber 1865 (II), Litterski 1997 (I, II); pl/co; ca, li, sa.

Xanthoparmelia conspersa (Ach.) Hale - Krempelhuber 1865 (III, *Parmelia c.*), Litterski 1997 (III); mo; si.

Xanthoria aphrodites Kalb, Poelt & S. Kondratyuk - Kondratyuk & Poelt 1997 (III); mo; Qu.

Xanthoria calcicola Oxner - Krempelhuber 1865 (?, *Physcia parietina* var. *aureola*), Güvenc & Öztürk 1994 (V, *X. aureola*), Litterski 1997 (I); pl/co, submo; ca, si.

Xanthoria candelaria (L.) Th. Fr. - Litterski 1997 (III), Kondratyuk & Poelt 1997; mo, salp; Pi, Qu.

Xanthoria ectaneoides (Nyl.) Zahlbr. - Krempelhuber 1865 (V, *Physcia parietina* var. *ectanea*); [pl/co]; -.

Xanthoria elegans (Link) Th. Fr. - Güvenc & Öztürk 1994 (V); pl/co; si.

Xanthoria cf. ***fulva*** (Hoffm.) Poelt & Petutschnig - Kondratyuk & Poelt 1997 (III, poorly developed); mo; Qu.

Xanthoria mediterranea Giralt, Nimis & Poelt - Giralt *et al.* 1993 (I), Litterski 1997 (I); pl/co; ca, li.

Xanthoria parietina (L.) Th. Fr. - Krempelhuber 1865 (IV, V, *Physcia p.*), Güvenc & Öztürk 1994 (IV, V), Aptroot 1996 (III), Litterski 1997 (I, III), Kondratyuk & Poelt 1997 (III), Litterski & Mayrhofer 1998 (I); pl/co, submo, mo; Be, Ce, Cr, Cu, Ol, Pi, Ps, Qu, Vi, br.

Xanthoria stiligera Giralt, Nimis & Poelt - Giralt *et al.* 1993 (I, IV); pl/co; ca.

Taxonomically not clear records

Placodium fusco-pallens Kremp. - Krempelhuber 1865 (?), typus in M; -; sa.

Porpidia stipata Kremp. - Krempelhuber 1865 (III), typus in M; [hmo]; wo.

Dubious records

Lecanora subfusca (L.) Ach. - Güvenc & Öztürk 1995 (V); pl/co; Ce.

Parmelia olivacea L. - Krempelhuber 1865 (?, III); [pl/co, mo]; -; a species of *Melanelia.*

Physcia parietina L. var. ***granulata*** Schaer. - Krempelhuber 1865 (IV); [pl/co]; **-;** probably *Xanthoria stiligera* or *Xanthoria mediterranea.*

Roccella tinctoria Ach. - Krempelhuber 1865 (IV, V); [pl/co]; -; probably *Roccella phycopsis.*

Zeora sordida Pers. var. ***pallide-flava*** Kremp. - Krempelhuber 1865 (?); -; -; probably *Lecanora rupicola.*

Index of synonyms

Alectoria jubata = Bryoria fuscescens
Anaptychia intricata = Tornabea scutellifera
Anaptychia obscura var. *orbicularis = Phaeophyscia orbicularis*
Anaptychia pulchella var. *dubia = Physcia dubia*
Anaptychia pulverulenta var. *angustata = Physconia muscigena*
Anaptychia pulverulenta var. *grisea = Physconia grisea*
Anaptychia pulverulenta var. *muscicola = Physconia distorta*
Anaptychia pulverulenta var. *venusta = Physconia venusta*
Anaptychia stellaris v. *aipolia = Physcia aipolia*
Anaptychia stellaris v. *ambigua = Physcia stellaris*
Anaptychia stellaris v. *hispida = Physcia adscendens*
Arthopyrenia punctiformis = Naetrocymbe punctiformis
Aspicilia mutabilis = Megaspora verrucosa var. *mutabilis*
Aspicilia praeradiosa = Lobothallia praeradiosa
Aspicilia viridescens = Aspicilia contorta
Biatora decipiens = Psora decipiens
Biatora triptophylla var. *corallinoides = Parmeliella triptophylla*
Biatorina michelettiana = Solenopsora olivacea ssp. *olivacea*
Blastenia lallavei = Caloplaca erythrocarpa
Buellia punctata = Amandinea punctata
Buellia venusta = Diplotomma venustum
Callopisma aurantiacum ß. *flavovirescens = Caloplaca flavovirescens*
Callopisma cerinum = Caloplaca cerina
Catapyrenium adami-borosi= Placidium adami-borosi
Catapyrenium michelii = Placidium michelii
Catapyrenium semaforonense = Placidium semaforonense
Catapyrenium tenellum = Placidium tenellum
Cetraria glauca = Platismatia glauca
Cladonia chlorophaea see *Cladonia pyxidata*
Cladonia endiviaefolia = Cladonia convoluta
Cladonia endivifolia = Cladonia convoluta
Cladonia pyxidata c. *pocillum = Cladonia pocillum*
Collema albo-ciliatum = Leptochidium albociliatum
Collema turgida = Leptogium turgidum
Diploschistes calcarius = Diploschistes candidissima
Diplotomma epipolium = Diplotomma alboatrum
Dirina repanda see *Dirina massiliensis* f. *massiliensis*
Dirina stenhammari = Dirina massiliensis f. *sorediata*
Endocarpon miniatum = Dermatocarpon miniatum
Endocarpon nodulosum = Dermatocarpon nodulosum
Evernia furfuracea = Pseudevernia furfuracea
Gyalolechia bracteata = Fulgensia bracteata
Lecanactis grumulosa = Lecanographa grumulosa
Lecanora atra = Tephromela atra
Lecanora chlarona = Lecanora chlarotera
Lecanora crassa = Squamarina cartilaginea
Lecanora crassa f. *macra = Squamarina cartilaginea*
Lecanora cypria = Tephromela atra var. *cypria*
Lecanora lentigera = Squamarina lentigera
Lecanora murorum y. *callopisma = Caloplaca saxicola*
Lecanora sienae = Lecanora horiza
Lecanora subfusca var. *distans = Lecanora allophana*
Lecidea conformis = Immersaria athroocarpa
Lecidea elata = Lecanora marginata
Lecidea enteroleuca var. *rugulosa = Lecidella elaeochroma*
Lecidea fumosa = Lecidea fuscoatra
Lecidea polycarpa = Lecidea lapicida var. *pantherina*
Lecidea sabuletorum var. *euphorea = Lecidella euphorea*
Lecidea sabuletorum, pilularis = Mycobilimbia sphaeroides
Leptogium atrocaeruleum = Leptogium lichenoides
Limboria candidissima = Diploschistes candidissimus
Parmelia acetabulum = Pleurosticta acetabulum
Parmelia ceratophylla var. *tubulosa = Hypogymnia*

tubulosa
Parmelia aspera = *Melanelia exasperata*
Parmelia carporrhizans = *Parmelina carporrhizans*
Parmelia conspersa = *Xanthoparmelia conspersa*
Parmelia exasperata = *Melanelia exasperata*
Parmelia luteonotata = *Neofuscelia luteonotata*
Parmelia pulla = *Neofuscelia pulla*
Parmelia quercifolia a *tiliacea* = *Parmelina tiliacea*
Parmelia tiliacea = *Parmelina tiliacea*
Peltigera polydactyla see *Peltigera neckeri*
Physcia callopisma = *Caloplaca flavescens*
Physcia parietina = *Xanthoria parietina*
Physcia parietina var. *aureola* = *Xanthoria calcicola*
Physcia parietina var. *ectanea* = *Xanthoria ectaneoides*
Physma compactum, Collema chalazanum = *Lempholemma chalazanum*
Placodium montagnei var. *calcarea* = *Protoparmelia montagnei*
Placodium radiosum = *Aspicilia radiosa*
Placodium saxicolum = *Lecanora muralis*
Placodium saxicolum var. *diffractum* = *Lecanora bolcana*
Psora lurida = *Lecidea lurida*
Psora ostreata = *Hypocenomyce scalaris*
Psoroma crassum ß. *caespitosum* = *Squamarina cartilaginea*
Psoroma fulgens = *Fulgensia fulgens*
Psoroma lentigerum = *Squamarina lentigera*
Thalloidima vesicularis = *Toninia sedifolia*
Toninia caeruleonigricans = *Toninia sedifolia*
Urceolaria calcarea = *Aspicilia calcarea*
Urceolaria ocellata = *Diploschistes ocellatus*
Urceolaria scruposa var. *gypsacea*, var. *cretacea* = *Diploschistes gypsaceus*
Urceolaria scruposa var. *bryophila*, var. *arenaria* = *Diploschistes muscorum*
Urceolaria villarsii = *Diploschistes ocellatus*
Urceolaria villarsii var. *macrior* = *Diploschistes muscorum*
Xanthoria aureola = *Xanthoria calcicola*

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CARACTERIZACIÓN ECOLÓGICA DE LOS ALCORNOCALES IBEROLEVANTINOS (ESTE DE ESPAÑA) BASADA EN BIOINDICADORES LIQUÉNICOS

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Keywords: Bioclimatology, Bioindicators, Cork-oak, Ecology, Epiphytes, Lichens, *Quercus suber*, Spain.

Abstract: ECOLOGICAL CHARACTERIZATION OF THE IBERO-LEVANTINIAN CORK-OAK FORESTS (EASTERN SPAIN) USING EPIPHYTIC LICHENS AS BIOINDICATORS. This study compares the epiphytic lichen floras of cork-oak forests from eastern Spain. The methodology was designed in such a way as to avoid subjectivity at all stages, from the sampling protocol to data analysis. Field work was carried out in 15 Catalonian localities, in mature stands of *Carici-Querco suberis sigmetum*, and in 9 localities of the Valencian Community, in mature stands of *Asplenio-Querco suberis sigmetum.* In each locality, ten trees were selected, and the lichens growing on virgin bark from 50 to 200 cm above the ground were identified. All together, 153 species were encountered, with 69 species present in both territories, and 33 found in at least three samplig plots. Multivariate methods of classification and ordination were used to analyze a matrix of stations and species based on presence/absence data. The classification clearly separated two main groups of stations, Catalonian and Valencian, with the exception of two Catalonian localities that were more related to the Valencian ones. This accords well with the climate of the two regions: the Catalonian cork-oak forests are subjected to a strong maritime influence, experiencing frequent fog episodes, whereas the Valencian ones are more continental and drier. The higher incidence of nitrophytic lichens in the Valencian cork-oak forests is probably due to dust accumulation on the trunks. Within the two groups of stations the lichen flora is diversified according to differences in temperature, rainfall, and relative humidity regimes. The results support the assumption that epiphytic lichens can provide important information on the phytoclimatical features of a territory.

Introducción

La sensibilidad de los líquenes y sus comunidades a diferentes parámetros ambientales está plenamente reconocida en la literatura. Esto los convierte en excelentes bioindicadores de factores climáticos relevantes para las plantas (temperatura, la humedad relativa del aire, precipitación, etc.), ya que suministran información de gran valor en la caracterización bioclimática de los territorios (Nimis 1981, 1993; Nimis & Loi 1982, 1984; Sergio *et al.* 1990; Nimis & Tretiach 1995; Fos & Barreno 1994a; Fos 1997; Barreno 1997, 1998). El planteamiento de trabajos comparativos entre áreas climáticamente heterogéneas, manteniendo el mismo sustrato, permite extraer conclusiones sobre las características generales del clima en cada territorio y, simultáneamente, sobre la incidencia de los parámetros climáticos que intervienen en la selección de las especies presentes en cada área (James *et al.* 1977; Hawksworth & Hill 1984).

En la Península Ibérica, el alcornoque (*Quercus suber* L.) tiene su óptimo en el cuadrante suroccidental. En el área levantina, forma bosques más o menos extensos en Cataluña (*Carici depressae-Quercetum suberis* (O. Bolós) Rivas-Martínez 1987 = *Quercetum ilicis galloprovinciale suberetosum* Br.-Bl. 1936) y en la Comunidad Valenciana (*Asplenio onpteridis-Quercetum suberis* Costa *et al.* 1985), sometidos a condiciones termo- y ombroclimáticas diferentes (Folch 1981; Costa *et al.* 1985; Costa 1986; Rivas-Martínez 1987; Vilar *et al.* 1989, 1994).

El objetivo de este estudio es comparar la flora

liquénica epífita sobre *Q. suber* en estas dos áreas. La presencia-ausencia de determinados conjuntos de flora y la aplicación de técnicas de análisis multivariante han permitido poner de manifiesto los factores más relevantes en la selección de los táxones en cada territorio y se han obtenido conjuntos de localidades florísticamente homogéneas que delimitan regiones climáticas uniformes.

Área de estudio

El área de estudio abarca los principales núcleos de alcornocales del Levante español (alcornocales iberolevantinos): Cataluña y Comunidad Valenciana (Fig. 1). Los alcornocales catalanes (Fig. 1A) se localizan en dos áreas de desigual importancia, una más extensa que abarca buena parte del sector nororiental de la Cordillera Catalana y otra que ocupa la vertiente meridional del extremo oriental de los Pirineos. Los valencianos (Fig. 1B) tienen una extensión más reducida y quedan limitados a las Sierras de Espadán y Calderona y algunos enclaves del Desierto de las Palmas. Las características climáticas — parámetros climáticos e índices bioclimáticos (Rivas-Martínez *et al.* 1991; Fos 1997) — de cada área se resumen en los diagramas ombroclimáticos de la Fig. 2. En general, los alcornocales catalanes reciben mayor precipitación y muestran un menor período de aridez estival (P = 685-804 mm; Imv = 2.8-4.2) que los valencianos (P = 503-637 mm; Imv = 4,7-7). La influencia litoral es más notable en los primeros, tanto por la amortiguación de la oscilación térmica como por la frecuencia de los episodios de nieblas o brumas. Además, en los valencianos, son relativamente frecuentes los episodios de vientos de poniente, muy cálidos y secos, que impiden la formación del régimen de brisas marítimas.

Las localidades muestreadas en cada territorios (Fig. 1) son las siguientes:

Localidades catalanas: 1) AGULLANA, Pla de Pujalts, 300 m, 31TDG8594; 2) DARNÍUS, Serrat del Sentinela, 220 m, 31TDG8590; 3) CAPMANY, Ctra. a Capmany, km 2, 120 m, 31TDG9390; 4) BEGUR, Puig Malaret, 180 m, 31TEG1846; 5) Begur, SA TUNA, 250 m, 31TEG1845; 6) PALAFRUGELL, Cap Roig, 60 m, 31TEG1436; 7) SANT SADURNÍ, Puig dels Cristians, 350 m, 31TDG9239; 8) SANTA CRISTINA d'Aro, Les Taules, 140 m, 31TEG0129; 9) Caldes de Malavella, Riera de RECLÀ, 120 m, 31TDG8627; 10) Caldes de MALAVELLA, Llagostera-Caldes de Malavella, km 5, 100 m, 31 TDG -

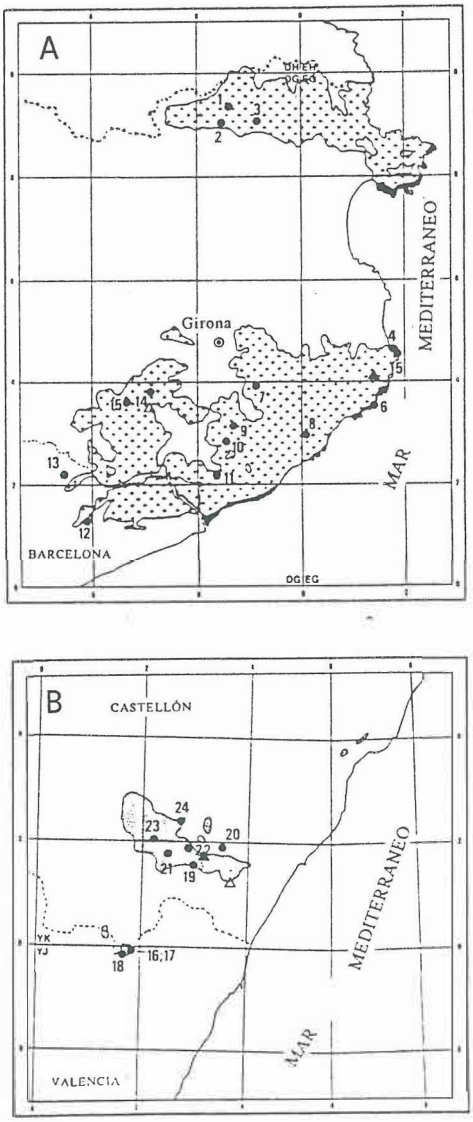

Fig. 1 - Áreas potenciales de los alcornocales iberolevantinos (zonas punteadas; tomado de Rivas-Martínez 1987). Situación geográfica de las localidades estudiadas. Retículo UTM de 20 km de lado. Los triángulos indican la localización de las estaciones meteorológicas (ver Fig. 2)

Potential areas of the ibero-levantinian cork-oak forests (dotted areas; according to Rivas-Martínez 1987) and location of the sampling stations. UTM lattice side is 20 km. Triangles: meteorological stations (see Fig. 2).

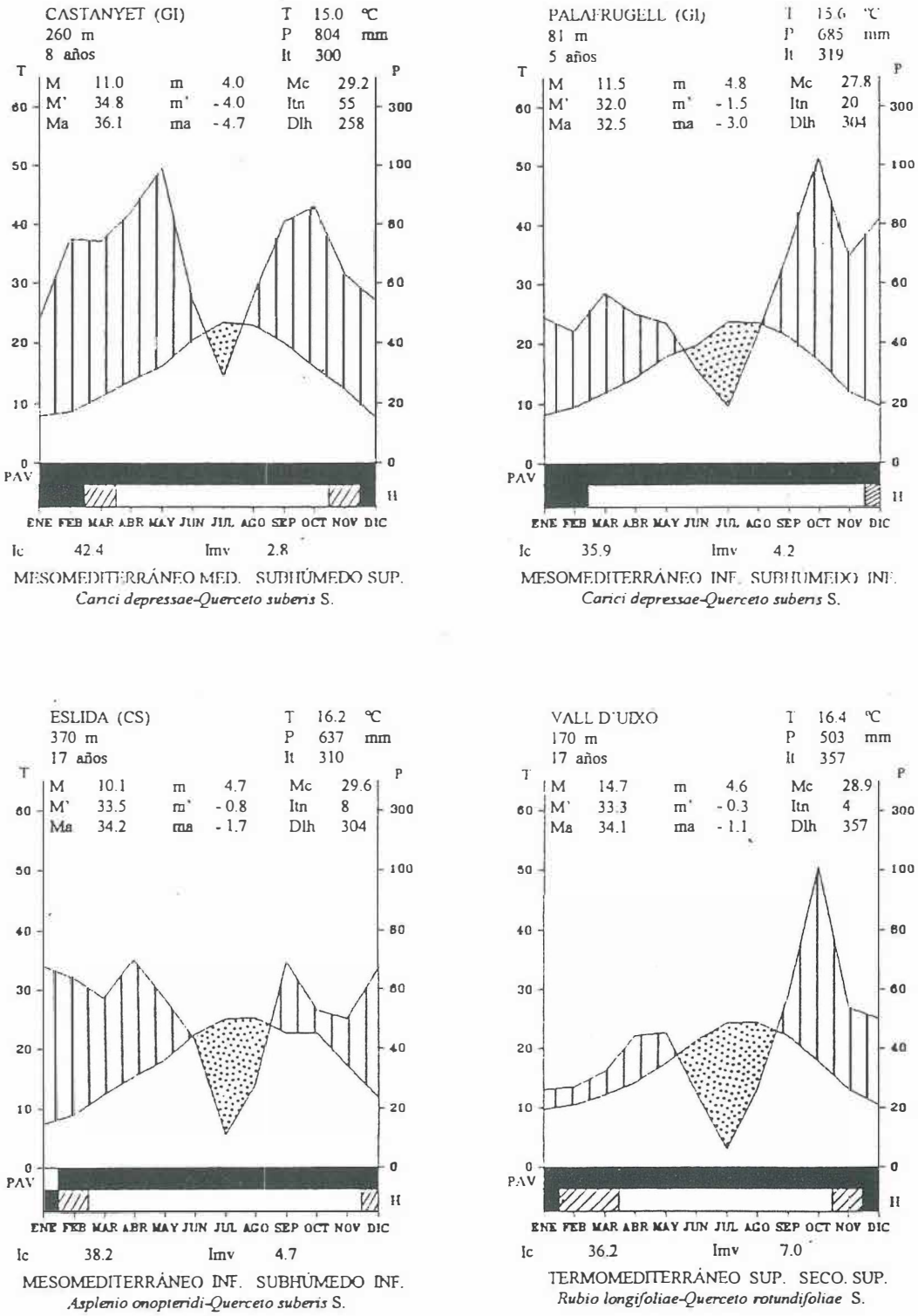

Fig. 2 - Diagramas ombroclimáticos de algunas localidades catalanas (Palafrugell, triángulo negro, y Castanyet, triángulo blanco en Fig. 1A) y valencianas (Eslida, triángulo negro, y Vall d'Uixó, triángulo blanco en Fig. 1B)(Rivas-Martínez *et al.* 1991).

Climatic diagrams of some Catalonian (Palafrugell, full triangle in Fig. 1A, and Castanyet, hollow triangle) and Valencian (Eslida, full triangle in Fig. 1B, and Vall d'Uixó, hollow triangle) localities, according to Rivas-Martínez *et al.* 1991.

8831; 11) LLORET de mar, Los Pinares, 180 m, 31TDG8520; 12) SANT CELONI, Serra del Solà, Torrent de Olzinelles, 220 m, 31TDG5814; 13) Fogàs de MONCLÚS, La Costa-Mosqueroles, km 6, 580 m, 31TDG5121; 14) BRUNYOLA, Anglés-Sta Coloma de Farnés, km 5, 220 m, 31TDG7138; 15) SANTA COLOMA de Farnés, Serrat del Corb, 260 m, 31TDG6736.

Localidades valenciano-castellonenses: 16) Serra, Serra Calderona, Bco. SARAGUTILLO (I), 550 m, 30SYJ1799) 17) Bco. SARAGUTILLO (II), 580 m, 30SYJ1698; 18) Serra, Serra Calderona, Font del BERRO, 550 m, 30SYJ1699; 19) CHÓVAR, Serra d'Espadà, Bco. del Carbón, 450 m, 30SYK2915; 20) ARTANA, Serra d'Espadà, El Hondo, 280 m, 30SYK3418; 21) Azuebar, Serra d'Espadà, MOSQUERA, 700 m, 30SYK2517; 22) AHÍN, Serra d'Espadà, Los Noguerales, 725 m, 30SYK2718; 23) Algimia de Almonacid, Serra d'Espadà, Bco. de AGUA NEGRA, 800 m, 30SYK2320; 24) Alcudia de Veo, Serra d'Espadà, Emb. de BENITANDÚS, 350 m, 30SYK2724.

Datos y Métodos

Se ha elaborado un catálogo florístico (matriz de presencia-ausencia de especies por localidades) destinado a poner de manifiesto las semejanzas y diferencias florísticas entre los alcornocales iberolevantinos. Para la recolección del material liquénico, en cada punto de muestreo, se han considerado 10 árboles que cumplían una serie de requisitos: pertenecer a las clases diamétricas medias (diámetro sobre corcho a 1.3 m del suelo entre 90-130 cm), inclinación del tronco inferior a 20° respecto a la perpendicular y, para que fuera posible la recolección de líquenes, altura de extracción del corcho inferior 1.50 m.

Con los inventarios obtenidos, se confeccionó una matriz de datos que sólo incluye las especies recolectadas sobre corcho virgen (bornizo) entre 50 cm y 2 m de altura, en todas las orientaciones. Esto no implica que toda la superficie se encuentre homogéneamente cubierta por la corteza original del árbol, sino que la recolección del material liquénico se ha limitado al bornizo. Esta delimitación del área de muestreo permite evitar la introducción de asimetrías debidas a parámetros diferentes de los que se pretende valorar. Así, quedan excluidas las especies de óptimo terrícola o saxícola silicícola que colonizan las bases de los troncos y las raíces superficiales (*Cladonia sp. pl.*, *Diploschistes scruposus*, *Lecidella carpathica*, *Parmelia pulla*, *Parmelia loxodes*, *Parmelia verrucigera*, etc.).

También, se han excluido aquellas especies encontradas únicamente en una localidad y sólo representadas por un individuo (*Arthonia galactites*, *A. pinastri*, *Arthothelium ilicinum*, *Bacidia hegetschweileri*, *Collema occultatum*, *Opegrapha vermicellifera*, *Ramalina obtusata*, etc.). En la Tab. 1 sólo se presentan las especies consideradas en los análisis estadísticos, lo que introduce diferencias cuantitativas respecto a los catálogos completos (Fos 1997).

La flora liquénica identificada en cada localidad ha sido analizada utilizando técnicas de análisis multivariantes (clasificación y ordenación), con objeto de obtener grupos de localidades con composición florística semejante. Para la clasificación numérica se ha aplicado la técnica conocida como Análisis Cluster, utilizando la distancia euclídea entre pares de localidades como medida de semejanza y el ligamiento de mínima varianza como algoritmo para la representación del dendrograma. Para la ordenación, se ha utilizado el Análisis de Componentes Principales (ACP), después de la transformación de los datos para análisis recíprocos. Todos los cálculos se han realizado utilizando el programa MULVA para estudio de la vegetación (Wildi & Orlóci 1983).

La caracterización ecológica de las especies está basada, fundamentalmente, en los trabajos de Barkman (1958), Wirth (1980) y Nimis (1993); además se ha tenido en cuenta toda la información recopilada en las numerosas publicaciones liquenológicas que aportan información en este sentido.

Resultados

El estudio de la flora liquénica epífita en los alcornocales iberolevantinos ha permitido obtener una matriz (Tab. 1) de 24 localidades (15 en Cataluña y 9 en la Comunidad Valenciana) y 153 especies (122 en Cataluña y 106 en la Comunidad Valenciana). Ambos territorios comparten 69 táxones, pero de ellos, sólo 33 están presentes en, al menos, tres localidades de muestreo. Estas asimetrías sugieren diferencias florísticas importantes entre los bosques de alcornoques del Este de España.

El análisis cluster (Fig. 3) revela aspectos interesantes sobre la diversidad de la flora liquénica epífita de *Quercus suber* en los alcornocales

Tab. 1 – Presencia-ausencia de las especies en las localidades estudiadas.

Presence of the species in the sampling stations.

ESPECIE	4	5	6	8	7	10	9	15	12	14	1	11	13	17	16	22	21	3	2	20	19	24	23	18
Agonimia opuntiella	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.
Amandinea punctata	.	1	1	.	1	1	1	.	.	1	1	.	1	.	1	1	1	1	1	1	.	1	1	1
Anaptychia ciliaris	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	.	.	.	.	.
Arthonia granosa	.	1	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
Arthonia pruinata	.	.	.	.	1	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Arthonia radiata	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	1	1	.	1	1	1	1	1	1
Arthothelium crozalsianum	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Arthothelium sardoum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Arthothelium spectabile	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bacidia rosella	.	.	.	.	1	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bactrospora patellarioides	1	1	1	1	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.
Buellia disciformis	.	.	1	.	1	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
Buellia ericina	.	.	1	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Buellia erubescens	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Buellia schaereri	.	.	.	.	.	1	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Caloplaca aegatica	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Caloplaca cerina	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.
Caloplaca cerinella	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	.	.	1	.	1	.
Caloplaca cerinelloides	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Caloplaca ferruginea	.	.	1	.	1	.	.	1	.	.	1	1	1	1	1	1	1	.	1	1	1	1	1	1
Caloplaca flavorubescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.
Caloplaca herbidella	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Caloplaca holocarpa	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1
Caloplaca hungarica	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Caloplaca lucifuga	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	1	.
Caloplaca obscurella	.	1	.	.	1	1	.	.	.	.	.	.	.	1	.	1	1	.	.	1	1	1	1	1
Caloplaca pollinii	.	.	.	1	1	1	.	.	1	.	1	.	1	1	1	1	1	1	1	1	1	1	1	1
Caloplaca sarcopisoides	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Candelaria concolor	.	.	1	.	.	1	.	.	1	.	1	.	1	.	.	.	.	1	1	1	1	1	.	.
Candelariella vitellina	.	.	1	.	.	.	.	.	.	.	.	.	1	.	1	.	1	.	1	1	1	.	.	1
Candelariella xanthostigma	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.
Catillaria chalybeia	.	.	.	.	.	.	.	.	.	1	.	.	.	1	1	1	1	.	1	1	1	.	1	1
Catillaria nigroclavata	.	1	.	1	.	.	.	.	.	1	.	.	1	1	1	1	1	1	.	1	1	1	1	1
Collema furfuraceum	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.	1	.	.	1	.
Collema subnigrescens	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.
Chrysothrix candelaris	1	1	1	1	1	1	1	1	1	1	1	1	.	.	.	1	1	1	1	.	.	.	.	.
Dimerella pineti	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Diploicia canescens	1	1	1	1	.	.	1	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.
Eopyrenula leucoplaca	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	1	.
Evernia prunastri	.	.	.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

ESPECIE	4	5	6	8	7	10	9	15	12	14	1	11	13	17	16	22	21	3	2	20	19	24	23	18
Gyalecta derivata	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gyalecta liguriensis	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hyperphyscia adglutinata	1	1	1	1	1	1	1	1	1	1	1	.	1	1	1	1	1	1	1	1	1	1	1	1
Hypogymnia physodes	.	.	.	.	.	1	.	1	.	1	.	.	1	.	.	1	1	.	.	.	.	.	.	.
Hypogymnia tubulosa	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	1	.	.	.
Lecania naegelii	1	1	1	1	1	.	.	1	.	.	.	.	1	1	1	1	1	1	1	.	1	1	1	1
Lecania cyrtella	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.
Lecania fuscella	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.
Lecanographa lyncea	.	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecanora argentata	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	1	.	.	.	.
Lecanora carpinea	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Lecanora circumborealis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1
Lecanora conizaeoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.
Lecanora chlarotera	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.
Lecanora expallens	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecanora horiza	.	.	.	1	1	.	.	.	.	.	.	.	1	1	1	1	1	.	1	.	.	.	.	1
Lecanora livido-cinerea	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecanora pallida	.	.	.	.	1	.	1	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecanora pulicaris	1	1	1	1	1	.	.	1	.	1	1	1	1	1	1	1	1	.	1	1	1	1	1	1
Lecanora rubicunda	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecanora strobilina	1	1	1	1	1	1	1	1	1	1	1	1	1	1	.	1	1	1	1	1	1	1	1	1
Lecanora sylvestris	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lecanora symmicta	.	.	.	1	1	.	.	.	.	1	.	1	1	.	.	.	.	1	1	.	.	.	.	.
Lecidella achristotera	.	.	.	1	1	.	1	1	.	.	1	.	1	1	1	1	1	.	1	1	.	.	.	1
Lecidella elaeochroma	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	.	.
Lecidella euphorea	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	1	1	.	.	.	.	1	1
Leptogium cyanescens	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Leptogium teretiusculum	.	1	.	.	1	.	.	.	.	.	1	.	.	1	1	1	1	.	.	.	1	1	1	.
Maronea constans	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Ochrolechia pallescens	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Ochrolechia turneri	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.	.	.	.	.	1
Opegrapha atra	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Opegrapha niveoatra	1	.	.	1	1	1	1	1	.	1	.	.	1	1	1	1	1	.	.	.	.	.	.	.
Opegrapha varia	1	1	1	.	1	1	1	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.
Opegrapha vulgata	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Parmelia caperata	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Parmelia chinense	1	1	.	.	1	.	.	1	1	1	1	1	1	1	1	1	1	1	1	.	.	1	1	.
Parmelia crozalsiana	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.
Parmelia glabra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Parmelia glabratula	.	.	.	.	1	.	.	1	.	.	.	1	.	1	1	1	1	.	.	.	1	.	.	.

ESPECIE	4	5	6	8	7	10	9	15	12	14	1	11	13	17	16	22	21	3	2	20	19	24	23	18
Parmelia hypoleucina	1	.	1	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Parmelia laciniatula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Parmelia quercina	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	1	1
Parmelia reticulata	1	1	1	1	1	1	1	1	1	1	1	1	1	.	.	.	.	1	1	1	.	.	.	.
Parmelia soredians	1	1	1	1	1	1	1	1	1	1	1	1	1	.	1	1	1	1	1	1	1	1	1	1
Parmelia subaurifera	.	.	.	.	.	.	1	1	1	1	1	1	1	.	1	1	1	.	.	.	.	.	1	.
Parmelia subrudecta	1	1	.	1	1	.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Parmelia sulcata	.	.	.	.	1	1	.	1	.	1	1	.	1	.	1	1	1	.	.	.	.	1	.	.
Parmelia tiliacea	.	.	.	.	1	.	.	1	1	.	1	.	1	1	1	1	1	.	1	1	1	1	1	1
Pertusaria albescens	.	.	.	.	1	.	.	.	.	.	1	1	.	1	1	1	1	.	.	.	.	.	.	1
Pertusaria amara	1	1	.	1	1	1	1	1	1	1	1	1	1	1	1	.	1	.	.	.	.	.	1	1
Pertusaria flavida	.	.	.	.	.	1	.	.	.	.	1	.	.	1	1	1	1	.	.	.	.	.	.	.
Pertusaria hemisphaerica	.	.	.	.	1	.	.	1	1	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.
Pertusaria heterochroa	1	1	1	1	.	1	1	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Pertusaria hymenea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Pertusaria leucostoma	.	.	.	1	1	.	.	.	.	1	.	.	.	1	1	1	1	.	.	1	1	1	1	1
Pertusaria pertusa	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.
Pertusaria pustulata	1	1	1	1	1	1	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phaeophyscia cernohorskyi	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	1	1	.	1	1
Phaeophyscia cloantha	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.
Phaeophyscia hirsuta	.	.	.	.	1	.	.	.	.	.	.	.	1	1	1	.	1	.	1	1	1	1	1	1
Phaeophyscia orbicularis	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	1	.	.	1	1
Phlyctis agelaea	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Physcia adscendens	1	1	.	1	1	1	1	1	1	1	1	.	1	1	1	1	1	1	1	1	1	1	1	1
Physcia aipolia	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	1	1	1	1	1	1
Physcia caesia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.
Physcia clementei	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	1
Physcia dubia	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	1	1	1	1	1	1	1
Physcia leptalea	.	.	.	1	.	.	.	.	.	1	.	.	1	1	1	1	1	1	1	1	1	1	1	1
Physcia stellaris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	1	.
Physcia tenella	1	.	1	1	1	1	.	1	.	1	1	.	1	1	1	1	1	1	1	1	1	1	1	1
Physcia tribacia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Physcia tribacioides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Physcia vitii	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Physconia enteroxantha	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	1	1	1	1	1	1
Physconia grisea	.	.	.	.	.	.	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.	1	.	.
Physconia perisidiosa	.	.	.	.	.	.	1	.	.	.	.	.	1	1	1	1	1	.	.	1	.	.	1	.

ESPECIE	4	5	6	8	7	10	9	15	12	14	1	11	13	17	16	22	21	3	2	20	19	24	23	18
Physconia servitii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
Physconia venusta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Polyblastiopsis subericola	1	.	1	.	1	1	1	.	.	1	1	.	1	.	1	1	.	.	.	.	.	.	.	.
Porina aenea	1	1	.	.	1	.	.	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
Pseudevernia furfuracea	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Pyrenula chlorospila	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pyrrhospora quernea	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Ramalina canariensis	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	1
Ramalina farinacea	.	.	.	.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	.	1
Ramalina fastigiata	1	.	.	1	.	.	.	1	.	.	.	.	.	1	1	1	1	.	.	1	1	1	1	1
Ramalina fraxinea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Ramalina pusilla	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rinodina capensis	.	1	.	.	.	.	.	.	.	.	1	.	1	1	1	.	.	.	.	.	.	1	1	1
Rinodina euskadiensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Rinodina plana	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Rinodina aff. poeltiana	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	1	1	.	.	.	.	1
Schismatomma decolorans	1	1	1	1	1	.	1	1	1	1	1	.	1	.	1	.	.	.	.	.	.	.	.	.
Scoliciosporum chlorococcum	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	1	1	.	.	.	.	.
Scoliciosporum sarothamni	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Scoliciosporum umbrinum	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.
Teloschistes chrysophthalmus	.	1	.	1	.	.	.	.	.	.	.	.	1	1	1	1	1	1	.	1	1	1	1	1
Thelenella modesta	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Trapeliopsis flexuosa	.	.	.	.	1	.	.	1	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.
Trapeliopsis granulosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Usnea ceratina	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Usnea cornuta	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Usnea dasaea	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Usnea esperantiana	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Usnea glabrata	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Usnea hirta	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Usnea mutabilis	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Usnea rubicunda	.	1	.	1	1	1	1	1	1	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.
Usnea subscabrosa	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Usnea wasmuthii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	1	1	.
Xanthoria candelaria	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.
Xanthoria parietina	1	1	.	1	1	.	1	1	.	.	1	.	1	1	1	1	1	1	.	1	1	.	1	1

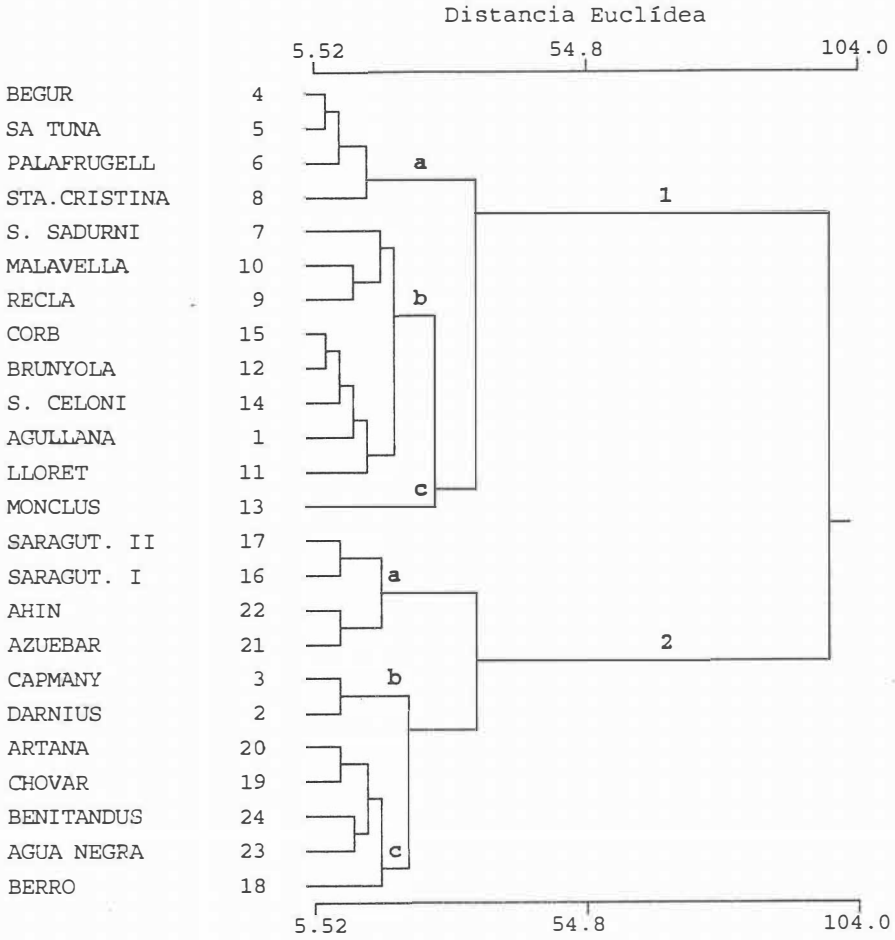

Fig. 3 - Clasificación de las localidades basada en los datos de la Tab. 1. La medida de semejanza es la Distancia Euclídea. La numeración de las localidades se indica en la figura 1.

Classification of sampling stations based on the data of Tab. 1. Resemblance measure: Euclidean Distance. Numbers as in Fig. 1.

levantinos. Esta diversidad parece responder a las condiciones bioclimáticas de cada territorio, al área biogeográfica y a la serie de vegetación. Las localidades se agrupan en dos conjuntos bien diferenciados (98.1 de distancia euclídea) que se corresponden con cada territorio estudiado, a excepción de las localidades muestreadas en la comarca del Alto Ampurdán gerundense, Darnius y Capmany, que se agrupan con las valenciano-castellonenses.

Los alcornocales catalanes (cluster 1) se subdividen inicialmente en dos grupos (32.4 de distancia euclídea): el cluster 1a (CAT.LIT. en Tab. 2) agrupa las estaciones litorales de Begur (Loc. 4), Sa Tuna (Loc. 5.), Palafrugell (Loc. 6) y Santa Cristina d'Aro (Loc. 8). Las diferencias responden de manera clara al grado de influencia marítima que soportan. En estas localidades hay una mayor diversidad, frecuencia y cobertura de los líquenes con *Trentepohlia* como fotobionte (*Arthonia granosa*, *A. radiata*, *A. pruinata*, *Opegrapha atra*, *O. niveoatra*, *O. varia*, *O. vermicellifera*, *O. vulgata*, *Pyrenula chlorospila*, etc.), indicadoras de una notable incidencia del litoral. A todo este conjunto de especies, se unen otras de carácter termófilo y/o de óptimo litoral (Tab. 2) como *Caloplaca aegatica*, *Diploicia canescens*, *Lecanora lividocinerea*, *L. rubicunda*, *L. sylvestris*, *Parmelia hypoleucina*, *Ramalina pusilla*, *R. canariensis*, que determinan la separación de este grupo y revelan las condiciones en las que se desarrollan estos alcornocales.

Las restantes estaciones se separan igualmente en dos grupos (24.2 de distancia euclídea). La distinción más clara es la de Monclús (Loc. 13): la localidad más alejada de la costa y situada a mayor altitud (cluster 1c; CAT.CONT.). La influencia

litoral se deja sentir bastantes kilómetros hacia el interior, pero se ve atenuada con el desplazamiento perpendicular a la línea de costa, siendo otros los parámetros que adquieren mayor importancia en la selección de las especies. Algunas de ellas todavía revelan su incidencia (*Bactrospora patellarioides*, *Caloplaca pollinii*, *Opegrapha niveoatra*, *Parmelia reticulata*, *Schismatomma decolorans*, etc.), pero ésta resulta insuficiente para anular la mayor continentalidad que impone su localización. Este contraste térmico es aprovechado por especies como *Hypogymnia tubulosa*, *Parmelia quercina*, *P. sulcata*, *Pseudevernia furfuracea* y *Usnea hirta*, indicadoras de una mayor amplitud térmica. La convergencia de diversas influencias, unido al buen estado de conservación del bosque son, probablemente, las que determinan que esta localidad tenga la mayor riqueza florística del territorio (54 especies; Fig. 4).

En el otro grupo (cluster 1b) se reúnen, por un lado, las situadas entre la línea de costa y los territorios potenciales de la serie del quejigo africano (*Carici-Querco canariensis sigmetum*) — Sant Sadurní (Loc. 7), Reclà (Loc. 9) y Malavella (Loc. 10) — las cuales, según demuestran los datos climáticos, los líquenes (Fos 1997) y la flora vascular que acompaña al alcornocal (Vilar *et al.* 1989; 1994), gozan de un ombroclima más húmedo. El otro grupo está formado por un conjunto más heterogéneo desde la óptica de su situación geográfica, pero que, evidentemente, comparte unas semejanzas florísticas resultantes de su proximidad ecológica. En éste grupo se aglutinan, por un lado, las estaciones que se localizan también próximas a estos territorios, pero más hacia el interior (Locs. 14. Brunyola y 15. Santa Coloma) y San Celoni (Loc. 12). Por otro lado, se aproximan las localidades de Agullana (Loc. 1) y Lloret (Loc. 11). En general, todas ellas corresponden a bosques maduros, poco alterados por las intervenciones selvícolas, y húmedos, aunque se observa un incremento de las especies fotófilas y una reducción de las termófilas y/o de tendencia litoral, que mantenían valores elevados en las localidades más húmedas (Tab. 2). Estas dos características ambientales parecen ser las que tienen mayor significación para explicar los conjuntos que se obtienen aunque, el grupo formado por Lloret y Agullana requeriría de estudios más profundos con objeto de poder descartar si esta afinidad se debe más a sus diferencias respecto a las restantes localidades catalanas que a las afinidades existentes entre ellas. En este sentido hay que recordar dos cuestiones: Lloret (Loc. 11) está situada

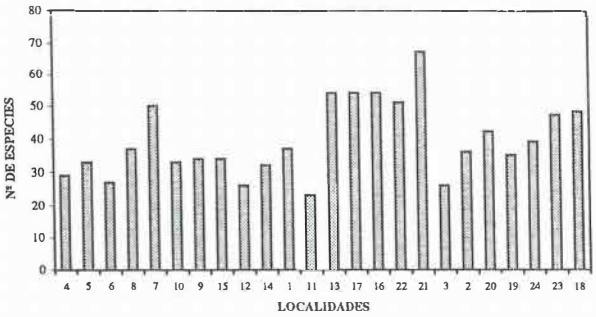

Fig. 4 - Riqueza de especies en las localidades estudiadas.
Species number in the sampling stations.

en una posición intermedia entre las localidades litorales y las más húmedas (Fig. 1A) y, sin embargo, prácticamente carece de elementos indicadores de termicidad o litoralidad. Por su parte, Agullana (Loc. 1) es la única localidad alto ampurdanesa que se mantiene próxima a las localidades catalanas. Probablemente, la mejor estructuración de este bosque frente a los aclarados y desprovistos del matorral que observamos en Darnius (Loc. 2) y Capmany (Loc. 3), sea la principal responsable de esta proximidad florística y de las diferencias con estas últimas. Lamentablemente, no existen datos climáticos de esta zona, que serían necesarios para poder establecer si las condiciones de humedad son tan limitantes y, al mismo tiempo, explicar las repercusiones que parecen tener las intervenciones realizadas en el bosque.

Las localidades valenciano-castellonenses se agrupan en el cluster 2 (Fig. 3), separadas en dos subgrupos bastante próximos (32.4 de distancia euclídea). El grupo 2a (VAL.STR. en Tab. 2) reúne las localidades Saragutillo (Locs. 16 y 17), Mosquera (Loc. 21) y Ahín (Loc. 22) que, por su estado de conservación, representan muestras excelentes de estos alcornocales (Costa *et al.* 1985; Costa 1986). Estos bosques bien estructurados ofrecen un ambiente más húmedo (Barkman, 1958) que favorece la entrada de todo un conjunto de especies (*Anaptychia ciliaris*, *Collema subnigrescens*, *Hypogymnia physodes*, *Parmelia crozalsiana*, *P. glabra*, *P. glabratula*, *Pertusaria flavida*, *P. hemisphaerica*, *P. hymenea*, *P. pertusa*, *Physconia venusta*) que faltan en las restantes estaciones, y determinan las mayores riquezas florísticas registradas en estos territorios (Fig. 4; Tab. 1). En estas localidades es donde se concentran las especies higrófilas (Tab. 2); ocasionalmente, pueden aparecer en otras, pero, en estos casos, siempre refugiadas en

Tab. 2 - Preferencias ecológicas de la flora liquénica epífita en los territorios estudiados, distinguiendo los grupos establecidos en el dendrograma de la Fig. 3. Xer = Xerófilo; Hig = Higrófilo; Esc = Esciófilo; Fot = Fotófito; Nitr = Nitrófilo; Anit = Anitrófilo; Oce = Oceánico; Suboc = Suboceánico; Cont = Continental; Term = Termófilo; Lit = Litoral. Caracterización ecológica basada en Barkman (1958), Wirth (1980), Nimis (1993), etc.

Ecological preferences of the epiphytic lichen flora in the two survey areas. Independent groups formed according to the dendrogram of Fig. 3 are distinguished. Xer = Xerophytic; Hig = Higrophytic; Esc = Skiophytic; Fot = Photophytic; Nitr = Nitrophytic; Anit = Anitrophytic; Oce = Oceanic; Suboc = Suboceanic; Cont = Continental; Term = Thermophytic; Lit = Maritime. Data from Barkman (1958), Wirth (1980), Nimis (1993), etc. (further explanation in the main text).

	Xer	Hig	Esc	Fot	Nitr	Anit	Oce	Suboc	Cont	Term	Lit
ALC. CATALANES	**29**	**42**	**20**	**53**	**44**	**18**	**15**	**22**	**9**	**17**	**21**
CAT.LIT. (Locs. 4, 5, 6, 8)	13	25	11	28	24	5	6	14	1	15	17
CAT.HD. (Locs. 7, 9, 10)	12	25	11	29	25	11	8	15	4	12	11
CAT.MED. (Locs. 1, 11, 12, 14, 15)	11	24	13	34	22	11	7	12	4	9	6
CAT-VAL. (Locs. 2, 3)	16	7	1	31	31	1	1	7	0	7	2
CAT.CONT. (Loc. 13)	15	16	2	33	26	6	2	7	4	5	3
ALC. VALENCIANOS	**35**	**27**	**9**	**63**	**60**	**9**	**5**	**16**	**7**	**14**	**12**
VAL.STR. (Locs. 16, 17, 21, 22)	26	26	9	53	47	9	3	12	5	10	8
VAL.TER. (Locs. 19, 20)	19	9	1	35	39	2	1	6	1	6	3
VAL.MED. (Locs. 23, 24)	20	11	3	38	38	2	2	7	4	7	4
VAL.XER. (Loc. 18)	19	12	3	35	32	1	1	6	2	8	4

microhábitats esciófilos y húmedos.

Las restantes localidades se han visto más afectadas como consecuencia de los incendios y por la deforestación. El cluster 2c (VAL.XER.) separa, primeramente, la localidad Font del Berro (Loc. 18), que junto con las estudiadas en el Barranco Saragutillo (Locs. 16 y 17), constituyen los núcleos de alcornocal termomediterráneo seco estudiados en la Sierra Calderona. Sin embargo, las diferencias estructurales y microambientales son suficientes para separarla florísticamente de éstas y de las demás localidades que forman este grupo. Las modificaciones introducidas por la alteración severa del bosque han provocado un empobrecimiento de la riqueza florística, con una disminución de los táxones de preferencias higrófilas, esciófilas y/o anitrófilas. Esta tendencia favorece el incremento de cobertura de las especies más tolerantes, sin que se observen asimetrías en las proporciones de especies favorecidas por las condiciones dominantes. Un hecho que no se refleja en los inventarios de presencia-ausencia, pero que marca una clara diferencia con las restantes estaciones de este área, es la cobertura mínima del estrato foliáceo. En Font del Berro (Loc. 18), los especies crustáceas son las que muestran coberturas más elevadas, pudiendo llegar a colonizar la mayor parte de la superficie. Sobre este estrato primario aparecen, de forma muy dispersa o concentrados a las posiciones más húmedas, los talos de las especies foliáceas que, por lo general, muestran un escaso desarrollo. Además, las especies fruticulosas están representadas por talos de 1-2 cm y no siempre han podido ser identificadas. Las limitaciones encontradas para las especies con mayores demandas hídricas están poniendo de manifiesto las condiciones de xericidad que afectan a este enclave y, al mismo tiempo, las razones que explican su independencia florística dentro del conjunto de localidades valenciano-castellonenses más afectadas por las intervenciones humanas.

El cluster 2c se completa con otro grupo que

sustitución de conjuntos florísticos que son desplazados por especies banales de amplia valencia ecológica (Boreham 1993; Canters *et al.* 1991; Hyvärinen *et al.* 1992; Kuusinen 1994a,b, 1996) que, aprovechando la nueva situación, avanzan desde la orla del bosque o desde sus posiciones de refugio para ocupar el espacio que ha quedado disponible. Las observaciones realizadas en los alcornocales iberolevantinos confirman este enunciado: en ambos territorios las estaciones más ricas corresponden a los bosques mejor conservados, aunque no siempre la menor diversidad coincida con la mayor alteración. Las características topográficas del bornizo, con sus profundas grietas, cavidades e irregularidades diversas, ofrece ambientes adecuados para que determinados elementos, algo más exigentes, puedan encontrar condiciones aptas, cuanto menos, para sobrevivir. Esta correspondencia entre elevada riqueza florística y estado de conservación del bosque, está generalizada para todos los alcornocales ibéricos (Fos 1997) y es un buen indicador de cómo estos ambientes favorecen comunidades epífitas diversificadas y bien estructuradas en sus tres estratos: crustáceo, foliáceo y fruticuloso (Barreno *et al.* 1988; Crespo *et al.* 1983; Atienza 1990; Etayo & Gómez-Bolea 1992; Fos & Barreno 1994a; Holien 1996; Kuusinen 1994a,b; Rose 1976).

En resumen, las localidades catalanas corresponden a bosques térmicos y húmedos, afectados por una influencia marítima u oceánica que ejerce un efecto atemperador de la amplitud térmica y, simultáneamente, representa un aporte suplementario de agua, incluso durante los meses de sequía estival. Estas condiciones se traducen en una mayor riqueza en especies higrófilas (59%), suboceánicas (20%) y oceánicas (14%) (Tab. 2). A este respecto, sorprende que con precipitaciones totales anuales entre 685 y 804 mm (Fig. 2), *Leptogium teretiusculum* sea el único cianolíquen encontrado en los bosques catalanes.

Los alcornocales valenciano-castellonenses presentan una flora liquénica epífita algo más continental y xérica, soportan un prolongado período de aridez estival que coincide con las máximas temperaturas y el aporte de agua por criptoprecipitaciones parece ser claramente inferior. Estas condiciones marcan diferencias con los bosques catalanes: disminuyen las especies higrófilas (44%), así como las de carácter suboceánico (15%) y oceánico (5%). Por otra parte, la menor cuantía y la distribución anual de las precipitaciones (Fig. 2) favorecen los procesos de acumulación de polvo y nutrientes. Con carácter general, y como corresponde a territorios mediterráneos, con largos períodos de depósito, la mayoría de las especies tienen preferencia por los ambientes ricos en sustancias nitrogenadas (87%).

Esta caracterización bioclimática contrasta con la información suministrada por otros estudios de flora y vegetación en estas mismas sierras. La flora vascular (Costa *et al.* 1985; Crespo-Villalva 1989; García-Fayos 1982, 1991) y la flora liquénica saxícola silicícola (Calatayud 1991; Calatayud & Barreno 1994) evidencian un carácter térmico y litoral que no encuentra correspondencia en la flora liquénica epífita. En la Tab. 2 puede comprobarse la escasa representación de especies indicadoras de estas condiciones, especialmente fuera del subconjunto formado por las localidades mejor conservadas (VAL.STR). Es evidente que estas asimetrías son el resultado de la mayor o menor incidencia de las condiciones dominantes en los diferentes tipos de hábitats. Los epífitos se encuentran más expuestos a las variaciones del clima mientras que los saxícolas están más favorecidos por la atenuación de la oscilación térmica y y la conservación de la humedad (Barkman 1958; Jörgensen, 1978). Además, estas zonas están influenciadas también por los vientos de poniente, secos y cálidos, que inhiben el régimen de brisas marinas, creándose un gradiente térmico y de humedad entre la costa y unos pocos centenares de metros hacia el interior (Mediavilla 1994).

La caracterización bioclimática de estos territorios, basada en la flora liquénica epífita, también coincide con los resultados obtenidos mediante la cuantificación del crecimiento radial del corcho de reproducción (Fos & Barreno 1994a,b; Fos 1997). En conclusión, el gradiente oceanidad-continentalidad parece ser el que selecciona principalmente los conjuntos de flora liquénica epífita en territorios mediterráneos.

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